AERONAUTICAL ENGINEERING REVIEW

JANUARY 1950

INSTITUTE OF AERONAUTICAL SCIENCES

JAN 25 1950

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FOR BETTER HYDRAULIC DEVICES

CAPITAL IS FIRST MAJOR U.S. AIRLINE TO USE GOODYEAR CROSS-WIND LANDING WHEELS

First Commercial Installation on New Super DC-3's For Capital Fleet

WASHINGTON—Capital Airlines has just announced that their new Super DC-3's will be the first commercial airliners in the United States equipped with the new Goodyear Cross-Wind Landing Wheel. This pioneer step by Capital foreshadows a new phase in commercial aviation.

The Goodyear Cross-Wind Landing Wheel is the only device of its kind approved by the CAA for commercial twin-engined transports. It is a self-contained mechanism built into the hub of the wheel that automatically compensates for the effects of cross winds on landings and take-offs.

Use of this new wheel will permit Capital Super DC-3's to take off and land in cross winds of high velocity.

Many Other Advantages

Wide adoption of this new device will reduce the expenditure for future airports. Its use will reduce the need for multiple runways and costly duplication of instrument-landing systems, lighting and other controls by making possible the construction of single-strip landing fields.

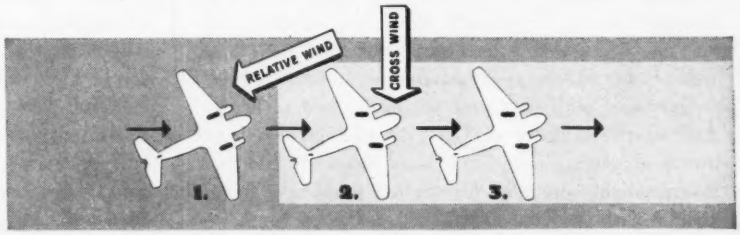
By March, Capital will be operating this new-type Super DC-3 equipped with Goodyear Cross-Wind Landing Wheels.

Can Cut Travel Time

It brings near the day when single-strip airports can be located along waterfronts or close to the heart of many cities. This will encourage greater air travel, by saving passengers millions of hours' ground travel to and from our present-day isolated airports.

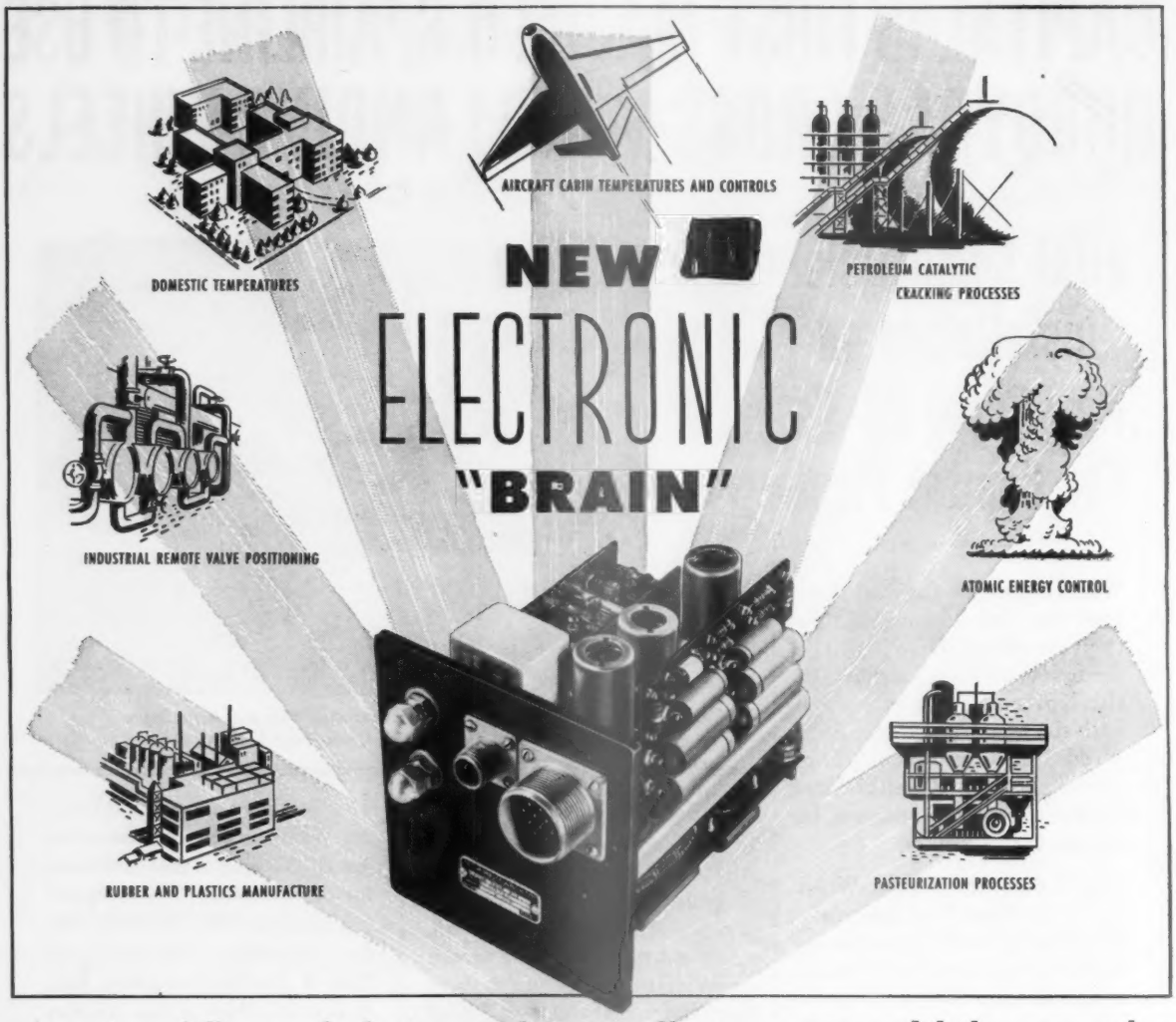
The Goodyear Cross-Wind Landing Wheel is now in production for DC-3's and is also available for other aircraft. For complete information write: Aviation Products Division, The Goodyear Tire & Rubber Company, Inc., Akron 16, Ohio or Los Angeles 54, California.

New Gear Permits Landings in High Velocity Cross Winds



1. ***Final Approach***—the pilot establishes proper drift correction angle to line up with the runway. 2. ***Landing***—The instant wheels touch the ground they caster automatically, due to the ship's forward momentum to line up with direction of the runway. 3. ***Landing Roll***—Castered wheels maintain straight-line roll down runway while ship safely weathervanes into relative wind.

GOODYEAR AVIATION PRODUCTS



Amazing AiResearch device mathematically computes and helps you solve unusual problems in precise control of temperature...position...and pressure!

Originally created to maintain aircraft cabin and engine temperatures at *pre-selected* levels—regardless of outside temperature—this ingenious electronic "brain" may well possess wide applications in other industrial fields.

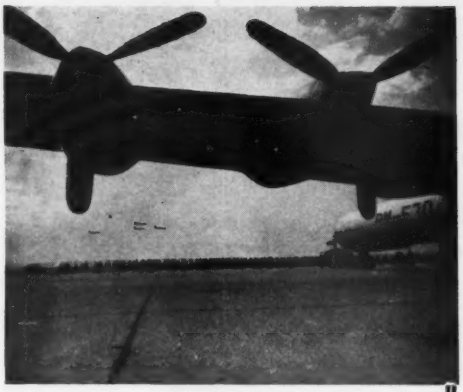
Operating with electronic sensitivity and speed, the AiResearch regulator can be used to control temperatures of gases, liquids, and solid materials and as a mathematical computer for similar problems. It can also be used for the exact *positioning* of controls—remote or otherwise. And it promises unusual abilities in solving problems of pressure, ducting, and safety control. We invite inquiries on its use in your field.

The Electronic Regulator is another example of the ability of AiResearch to design and *manufacture* specialized equipment for hard-to-do jobs. It indicates why nearly every type of high-altitude and jet aircraft produced in the U. S. carries AiResearch equipment.

Whatever your field—AiResearch engineers—designers and manufacturers of rotors operating in excess of 100,000 rpm—invite your toughest problems involving high speed wheels. Specialized experience is also available in creating compact turbines and compressors; actuators, with high speed rotors; air, gas and liquid heat exchangers; air pressure, temperature and other automatic controls.

AiResearch
DIVISION OF
THE GARRETT CORPORATION

An inquiry on your company letterhead will receive prompt attention.
AiResearch Manufacturing Company,
Los Angeles 45, California.



Cover—I.A.S. group visits Wright-Patterson Air Force Base (see pp. 14–15).

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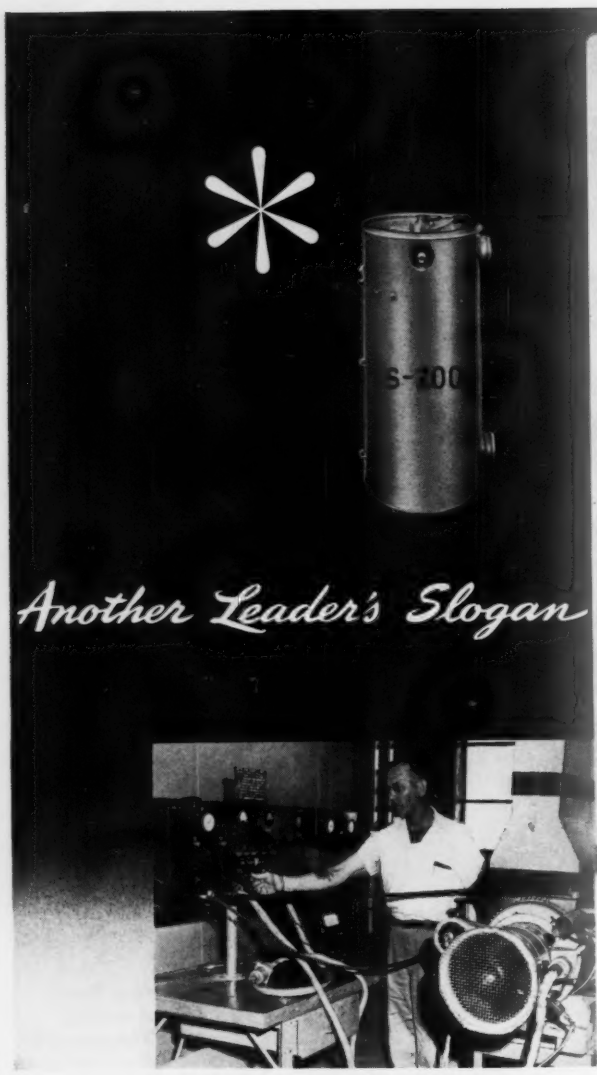

Another Leader's Slogan

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over billions of passenger miles!
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that 100% Janitrol equipment helps to make good

Eastern leaves nothing to chance! In the photo above Mr. Tony Finiels uses up-to-the-minute test equipment at Eastern's new heater test room in Miami to check a specially developed heater package for Constellations, containing a Janitrol 100,000 Btu per hour heater. Such careful *attention to every detail* backs up Eastern's great emphasis on economy and dependability.

Eastern's Great Silver Fleet—so well known for its long-standing records of safety, dependability, and profits—is Janitrol-heater-equipped—100%. Eastern's 51 DC-3's have Janitrol's famous model S-200; 18 DC-4's are equipped with S-40's and S-100's and 20 new-type Constellations use the 100,000 Btu per hour Janitrol heater. We're proud that Eastern is among the many airlines which rely on Janitrol for safe, dependable heating . . . Call in a Janitrol representative for help in solving your commercial or military aircraft heating requirements.

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Central District Office, Engineering Development and Production, Columbus, Ohio; Headquarters, Toledo, Ohio.

I.A.S. News

A Record of People and Events of Interest to Institute Members

"Dutch" Kindelberger Heads Institute in 1950

New President Succeeds Burden in List of Distinguished Leaders of I.A.S.; Wellwood E. Beall, William K. Ebel, William Littlewood, E. G. Stout Named Vice-Presidents; Elmer A. Sperry, Jr., Elected Treasurer.

JAMES HOWARD "DUTCH" KINDELBERGER, skillful leader of North American Aviation, Inc., has been elected eighteenth President of the Institute of the Aeronautical Sciences, succeeding the well-known William A. M. Burden, who joins the steadily growing list of distinguished Americans who have served as I.A.S. Presidents.

In addition to Mr. Kindelberger, the Council elected a new slate of Vice-Presidents and a new Treasurer for 1950.

▶ **1950 Slate**—New Vice-Presidents are Wellwood E. Beall, Vice-President of Engineering and Sales, Boeing Airplane Company, Seattle; William K. Ebel, Vice-President in Charge of Engineering, Canadair, Ltd.; William Littlewood, Vice-President of Engineering, American Airlines System; and E. G. Stout, Assistant to Chief Engineer, Consolidated Vultee Aircraft Corporation.

The new Treasurer is Elmer A. Sperry, Jr., Vice-President and Treasurer, Sperry Products, Inc. Mr. Sperry served as an I.A.S. Vice-President in 1949.

Mr. Kindelberger, whose election brings a representative West Coast leader of the industry to head the Institute this year, in conformance with I.A.S. policy to rotate the office between East and West Coasts, was born in Wheeling, W. Va., on May 8, 1895.

After receiving his early education in Wheeling, he went to work at the age of 16 for the National Tube Company in his home town, where he remained until 1913, when he became a draftsman and inspector with the U.S. Army Engineering Corps. In 1916, he entered Carnegie Institute of Technology but enlisted in the Army Engineering Corps in May, 1917. After six months on civil engineering projects, Mr. Kindelberger transferred to the Army Air Service, and, following completion of advanced flight training, he served as instructor at Park Field, Memphis, Tenn.

▶ **Works for Martin**—"Dutch" was still in uniform when he went to work as a draftsman at Glenn L. Martin's plant in Cleveland shortly after the Armistice in 1918. In 1920, he became chief draftsman and assistant chief engineer under Donald Douglas, who was then Martin's chief engineer.

It was in July, 1934, that he became president of General Aviation Manufacturing Corporation, Baltimore, Md. Six months later, he was named President and Managing Director of North American Aviation, Inc., with which firm he has remained ever since. He is now Chairman of the Board and Chief Executive Officer.

A Fellow and former Vice-President of the I.A.S., Mr. Kindelberger is a Governor of the Aircraft Industries Association of America. Early in 1942, he was elected first president of the Aircraft War Production Council, and, in 1947, he served on the advisory council to the Congressional Aviation Policy Board. He now serves on the National Industrial Reserve Review Committee and the Aircraft Industry Advisory Committee of the U.S. Munitions Board.

I.A.S. President for 1950: *James H. Kindelberger, Chairman of the Board, North American Aviation, Inc., has been chosen by the Council to head the Institute for the new year.*

National Meetings Calendar

Jan. 23–26	Eighteenth Annual Meeting, Hotel Astor, New York
March 24	Flight Propulsion Meeting, Hotel Carter, Cleveland

I.A.S. Eighteenth Annual Meeting & Honors Night Dinner

Hotel Astor — **New York City**

Final Program

Monday, January 23

8:30 A.M. — **REGISTRATION**
9:00 A.M.–12:00 Noon — North Ballroom

ROTATING WING AIRCRAFT

(Joint Session with American Helicopter Society)
Chairman—**Alexander Klemin**
President, American Helicopter Society

Practical Instrument Flying of Helicopters—O. Q. Niehaus, Chief Test Pilot, and Joseph A. Cannon, Bell Aircraft Corporation

A Type of Lifting Rotor with Inherent Stability—Kurt H. Hohenemser, Chief of Aerodynamics, Helicopter Division, McDonnell Aircraft Corporation

An Explanation of Some Important Stability Parameters That Influence Helicopter Flying Qualities—Alfred Gessow and Kenneth B. Amer, Aeronautical Research Scientist, Langley Aeronautical Laboratory, N.A.C.A.

Design and Operational Features of the Sikorsky 1,000-Hp. Rotor Test Stand—Harry Jensen, Chief Test Engineer, Sikorsky Aircraft Div., United Aircraft Corp.

9:00 A.M.–12:00 Noon — East Ballroom

INSTRUMENTS

Chairman—**Richard M. Mock,** President, Lear, Inc.

Acoustic Measurement of Airstream Parameters—V. B. Corey, Manager, Engineering Physics Division, Fredric Flader, Inc.

An Internal Six-Component Balance for Model Testing at High Speeds—Henry H. Hoadley, Head, Wind Tunnel Section, Research Department, United Aircraft Corporation

A Precision Omnidirectional Radio Range for the Terminal Area—Joseph Lyman, Engineering Department Head, and G. Litchford, Engineering Section Head, Aircraft Radio Research Department, Sperry Gyroscope Company

2:00 P.M.–5:00 P.M. — North Ballroom

AERODYNAMICS I

Chairman—**George S. Schairer,** Staff Engineer, Aerodynamics and Power Plant, Boeing Airplane Co.

A Mechanical Analogy for Hypersonic Flow—H. Reese Ivey, Langley Aeronautical Laboratory, N.A.C.A.

Lift on Inclined Bodies of Revolution in Hypersonic Flow—G. Grimminger, Scientific Warfare Advisor, Department of Defense, Washington, E. P. Williams, Engineer, and G. B. W. Young, The RAND Corporation

The Transient Temperature Distribution in a Wing Flying at Supersonic Speeds—Joseph Kaye, Associate Professor, Mechanical Engineering, Massachusetts Institute of Technology

The Characteristics of Supersonic Wings Having Biconvex Sections—Beverly J. Beane, Analytical Engineer, Research Department, United Aircraft Corporation

7:30 P.M. — Grand Ballroom

Honors Night Dinner

Presentation of the Institute's Annual Awards and Honors

Walter Lippmann, Columnist and News Analyst, will speak on the outlook for world peace, as he saw it on his recent tour of Europe and the Far East. He will emphasize the important role of aviation and air power.

Tuesday, January 24

8:30 A.M. — **REGISTRATION**
9:00 A.M.–12:00 Noon — North Ballroom

AERODYNAMICS II

Chairman—**Arnold M. Kuethe,** Chief Scientist
Office of Air Research, A.M.C. Wright-Patterson A.F.B.

On the Stability of Two-Dimensional Smooth Transonic Flows—Y. H. Kuo, Professor, Cornell University

First- and Second-Order Theory of Supersonic Flow Past Bodies of Revolution—Milton Van Dyke, California Institute of Technology and The RAND Corporation

The Rolling-Up of the Trailing Vortex Sheet and Its Effect on the Downwash Behind Lifting Wings—John R. Spreiter and Alvin H. Sacks, Ames Aeronautical Laboratory, N.A.C.A.

The Hot-Wire Anemometer in Supersonic Flow—L. S. G. Kovasznay, Asst. Prof. of Aeronautics, The Johns Hopkins Univ.

Luncheon

Guest-of-Honor and Principal Speaker
Rear Admiral C. M. Bolster, U.S.N.
Asst. Chief for Research and Development, BuAer

2:00 P.M.–5:00 P.M. — North Ballroom

AERODYNAMICS III

Chairman—**C. E. Pappas**
Chief of Aerodynamics, Republic Aviation Corporation

Periodic Motions of a Rectangular Wing Moving at a Supersonic Speed—H. J. Stewart, Professor of Aeronautics, and T. Y. Li, California Institute of Technology

The Longitudinal Stability of Elastic Swept Wings at Supersonic Speed—Charles W. Frick, Ames Aero. Lab., N.A.C.A.

A Method of Determining Some Aerodynamic Coefficients from Supersonic Free-Flight Tests of a Rolling Missile—R. E. Bolz, Asst. Professor, Aero. Engineering, Rensselaer Polytechnic Institute, and John D. Nicolaides, Aerodynamicist, Free-Flight Aerodynamics Branch, Ballistic Research Laboratories

A Contribution to a Generalized Theory of Shock Waves—L. Meyerhoff, Research Associate, Department of Aero. Eng. and Applied Mechanics, Polytechnic Institute of Brooklyn

8:00 P.M.–11:00 P.M. — North Ballroom

AEROELASTICITY

Chairman—**Martin Goland**
Chairman, Engineering Mechanics Div., Midwest Research Inst.

A System for the Excitation of Pure Natural Modes of Complex Structure—Robert C. Lewis and Donald L. Wrisley, Aero Elastic and Structures Research, Department of Aeronautical Engineering, Massachusetts Institute of Technology

The Solution of Aeroelastic Problems by Electronic Analog Computation—Jonathan Winson, In Charge of Dynamics, Pilotless Plane Division, Fairchild Engine & Airplane Corp.

The Gyroscopic Effect of a Rigid Rotating Propeller on Engine and Wing Vibration Modes—R. H. Scanlan, Associate Professor of Aeronautical Engineering, and John C. Truman, Rensselaer Polytechnic Institute

A Recurrence Matrix Solution for the Dynamic Response of Elastic Aircraft—John C. Houbolt, Langley Aeronautical Laboratory, N.A.C.A.

Wednesday, January 25

8:30 A.M. — **REGISTRATION**
9:00 A.M.–11:30 A.M. — East Ballroom

METEOROLOGY I

(Joint Session with the American Meteorological Society)
Chairman—**Capt. H. T. Orville, U.S.N.**
President, American Meteorological Society

Observations and Theory of Flow over Long Ridges—Joachim Kuettner and Philip Duncan Thompson, Atmospheric Analysis Laboratory, Geophysical Research Directorate, A.F. Cambridge Research Laboratories

The Influence of Wind Gradient and Unsteady Flow Effects on Short Take-Off Runs—Holt Ashley, Professor, and Donald Nielson, Department of Aero. Eng., M.I.T.

Vortex Thermometer for Measuring True Air Temperatures from an Airplane—Bernard Vonnegut, General Electric Research Laboratory

The Measurement of Temperature in the Presence of Water Particles—Patrick J. Harney, Dept. of Meteorology, M.I.T.

9:00 A.M.–12:00 Noon North Ballroom

STRUCTURES

Chairman—**Ira G. Hedrick,** Chief of Structures Grumman Aircraft Engineering Corporation

An Initial Approach to the Overall Structural Problems of Swept Wings Under Static Loads—E. E. Sechler, Professor of Aeronautics, M. L. Williams, and Y. C. Fung, Guggenheim Aeronautical Laboratory, California Institute of Technology

Types of Inelasticity of Structural Materials and Procedures of Design—Alfred M. Freudenthal, Professor of Civil Engineering, Columbia University

Analysis of the Elastic and Plastic Stability of Sandwich Plates by the Method of Split Rigidities—P. P. Bijlaard, Professor, Institute of Technology, Delft, Holland (on leave), Associate Professor, Cornell University

Column Behavior in the Plastic Stress Range—John E. Duberg, Aeronautical Research Scientist, and Thomas W. Wilder, III, Structures Research Division, Langley Aeronautical Laboratory, N.A.C.A.

Luncheon

Guest-of-Honor and Principal Speaker

Major General Donald L. Putt

Director, Research and Development Office
Deputy Chief of Staff, Materiel, U.S.A.F.

2:00 P.M.–5:00 P.M. North Ballroom

AIRCRAFT DESIGN

Chairman—**W. B. Bergen**
Chief Engineer, The Glenn L. Martin Company

Lateral Control Devices for Use with Full-Span Flaps on Straight and Swept Wings—F. M. Rogallo, J. G. Lowry, and J. Fischel, Langley Aeronautical Laboratory, N.A.C.A.

The Influence of Design Parameters on the Performance of Subsonic Air Inlets—Howard E. Roberts, Group Leader, and B. D. Langtry, Aerodynamicist, Aero-Thermodynamics Group, Aerodynamics Section, El Segundo Plant, Douglas Aircraft Company, Inc.

Air-Line Pilot Questionnaire Study on Cockpit Visibility Problems—Thomas M. Edwards, C.A.A. (Indianapolis)

Development of High-Speed Water-Based Aircraft—Ernest G. Stout, Assistant to the Chief Engineer, Consolidated Vultee Aircraft Corporation

2:30 P.M.–5:00 P.M. East Ballroom

METEOROLOGY II

(Joint Session with American Meteorological Society)

Chairman—**F. W. Reichelderfer,** Chief, U.S. Weather Bureau

Results of Recent Investigations of the Meteorological Conditions Conducive to Aircraft Icing—William Lewis, U.S. Weather Bureau

The Control of Precipitation from Cumulus Clouds by Employment of Various Seeding Techniques—Irving Langmuir, General Electric Research Laboratory

Radar RHI Scope Movies of a New England Storm—Myron G. H. Ligda, Dept. of Meteorology, M.I.T.

5:00 P.M. North Ballroom

I.A.S. BUSINESS MEETING

8:00 P.M.–11:00 P.M. North Ballroom

AIR TRANSPORT

(In Cooperation with the Flight Safety Foundation)

Chairman—**Jerome Lederer,** Director, Flight Safety Foundation

Service Testing of Prototype Air Transports—W. E. Koneczny, Chief of Airworthiness Division, C.A.B

Progress in Fire Prevention

In Flight—H. L. Hansbury, Power Plant Development Section, Federal Airways Exp. Sta., C.A.A. (Indianapolis)

Following Crash—Lewis A. Rodert, Chief of Flight Branch, Lewis Flight Propulsion Laboratory, N.A.C.A.

A Note on Crashworthiness—William I. Stieglitz, Design Engineer—Safety, Republic Aviation Corporation

Kinematic Behavior of the Human Body During Deceleration—Edward R. Dye, Head of Development Division, Cornell Aeronautical Laboratory

Maintenance of Safety Attitudes in Air Transport Operation—Robert Knight, Director of Safety, American Airlines, Inc.

Thursday, January 26

8:30 A.M. **REGISTRATION**

9:00 A.M.–11:30 A.M. North Ballroom

Symposium

JET ENGINE INSTALLATION DESIGN PROBLEMS

Chairman—**S. T. Robinson,** Sanderson & Porter

Airplane Designers' Point of View

Primary Power Plant—Richard Hutton, Chief Development Engineer, and John Karanik, Chief Power Plant Installations Engineer, Grumman Aircraft Engineering Corporation

Systems and Accessories—John S. McCarthy, Power Plant Engineer, McDonnell Aircraft Corporation

Engine Manufacturers' Point of View

M. C. Benedict, Aviation Gas Turbine Div., Westinghouse Elec. Corp.

Dimitrius Gerdan, Allison Div., General Motors Corp.

R. E. Small, Aviation Gas Turbine Div., General Elec. Corp.

Charles Jewett, Wright Aeronautical Corp.

Willard Gorton, Pratt & Whitney Div., U.A.C.

1:00 P.M.–5:00 P.M.

INSPECTION TRIP

WRIGHT AERONAUTICAL CORPORATION

Wood-Ridge, New Jersey

The visit will include a tour of engineering labs and testing facilities. Among these will be the new ram-jet laboratory, which can simulate supersonic flight speed from sea level to 80,000 ft, gas-turbine development lab, burner test rigs, compressor research unit, and supersonic air flow test rigs. A nominal fee will be charged for bus transportation.

Because of the classified nature of the material to be shown, it will be necessary for those making the trip to provide evidence of security clearance. Security forms requesting permission to make the inspection trip can be obtained by writing to the Institute office. The size of the group must be limited, so it is suggested that you request forms at once.

AIRBRAKE FOR MARTIN XB-51

Two design features enhance operations of The Glenn L. Martin Company's XB-51: for landings, new Martin bomber has a parachute stowed aft which may be released at pilot's discretion for more rapid deceleration; JATO bottles attached on fuselage sides near the tail to assist take-offs from smaller combat-area fields or landing strips. Each of the three J-47 jet engines produces more than 5,200 lbs. thrust.

Traffic-Control Device to Reduce In-Flight Delays Revealed by Damon

A device that will reduce in-flight delays by assuring landing-time reservations for aircraft, one of three major pieces of traffic-control equipment being developed under common civil-military program of the Air Navigation Development Board, has been revealed by Chairman Ralph Damon, F.I.A.S., President of T.W.A.

▶ **Aid to Jet Operations**—Such a device will go far toward overcoming operational difficulties of commercial jet-transport use, which, under present conditions, poses the problem of stacking over an airport with a limited fuel supply.

Development of Airport Time Utilization equipment has been assigned to the Civil Aeronautics Administration, which will conduct the work at its Indianapolis Technical Development and Evaluation Center.

Mr. Damon said that projects also had been launched for development of Airport Surface Detection equipment to help controllers regulate traffic on runways and taxiways during bad visibility, and of a radar ground interrogation–air reply system by means of which controllers can determine aircraft identity, height, and location. This equipment will be developed by the Air Force at its Watson Laboratories, Red Bank, N.J., while the Transpondor-Secondary Radar System, described by some as the answer to a traffic controller's prayer, has been assigned to the Navy Department for development by its Bureaus of Aeronautics and Ships.

▶ **Three Study Contracts Let**—Damon also revealed that, while assigning actual development work to member government agencies, the Board has let three study contracts directly.

One contract just getting started calls for a group at Cornell Aeronautical Laboratory to investigate probable characteristics of aircraft that might fly the common system 10 or 15 years from now.

Another group at the same institution is studying how Airport Time Utilization equipment at a number of airports can be integrated into a network. Mr. Damon said that gratifying progress was being made on this project.

The third study contract is with the Franklin Institute of Philadelphia, which is investigating the desirability and practicability of building a complete air-traffic control simulator and small simulators for study of individual air-traffic control problems.

In addition to Chairman Damon, A.N.D.B. is composed of Col. W. B. Larew, Army; Captain W. P. Cogswell, Navy; Col. S. A. Mundell, Air Force; and J. E. Sommers, C.A.A. B. A. Denicke, M.I.A.S., is Executive Secretary.

Air Safety Awards Presented to Institute Members

Four awards for outstanding contributions to the field of flying safety were presented by the Flight Safety Foundation last October 20. They were sponsored by *Aviation Week*, a McGraw-Hill publication.

Citations for 1949 award winners were to:

• **American Airlines System**—for preparation, production, and utilization in crew training of the sound film, *This Way Out*, which delineates the most efficient procedures to be taken by crew members to assure safety of passengers in the rare instances of an emergency in flight.

• **Hugh de Haven, M.I.A.S.**—for initiative, ability, persistence, and personal effort in establishing criteria for development of a safer environment for occupants of aircraft and for securing recognition of principles of design which will reduce the rate of fatalities in survivable aircraft accidents.

• **Leonard M. Greene, M.I.A.S.**—for development of a successful stall-warning indicator now widely recognized and adopted by the aviation industry to reduce the accident potential of the unpremeditated stall. The initiative, persistence, and resourcefulness displayed by Mr. Greene in establishing the value of his development are considered to be an integral part of this award.

• **United Air Lines, Inc.**—for the preparation, production in cooperation with the U.S. Coast Guard, and utilization in crew training of sound motion pictures having to do with safety in overwater flying.

William A. M. Burden, 1949 President of the I.A.S., made the presentations after a short speech by Jerry Lederer, F.I.A.S., President of Flight Safety Foundation, a nonprofit organization established to cooperate with the aviation industry on air-safety problems.

Brig. Gen. Harold R. Harris, U.S.A. (ret.), Vice-President and General Manager of American Overseas Airlines, Inc., and an I.A.S. Fellow, discussed safety problems of future jet-transport operations.

General Harris advocated that American operators, "both civilian and military," should combine with manufacturers in this country to arrange for the design and building of medium-range jet aircraft carrying 50 passengers for 1,850 miles with considerable fuel reserve and a trans-atlantic jet plane capable of carrying 50 passengers 3,500 miles against average headwinds with sufficient reserves.

Engineering Profession Unity Discussed at E.J.C. Meeting

Representatives of 14 leading engineering societies met last fall to study suggestions for increasing the unity of the engineering profession.

▶ **E.J.C. Invitation**—The Engineers Joint Council, which has been studying the suggestions for some time, invited 16 of the leading engineering societies to send representatives to take part in an exploratory meeting to discuss the subject.

As a result, with 14 member bodies represented, there was a full and free discussion of the whole problem.

There was general agreement among the members that some steps looking toward organizing for increased unity

of the profession would be desirable. It was felt that if an organization is to speak for the profession as a whole, it should have a structure that would enable it to respond to the various services that it may perform.

No conclusion was reached as to the form that such a structure might take. However, the group felt that the first approach to this subject would best be made through considering methods for closer cooperation between the existing organizations and for modifying and perhaps grouping some of these organizations rather than to consider establishment of an entirely new additional organization.

▶ **Planning Body Named**—As a result, a Planning Committee was appointed from members of the group, which was charged with the responsibility for preparing statements regarding various alternate plans of achieving this aim and reporting back to the main group. Date for the next meeting of the main group was set tentatively for January 27.

Among those represented at the meeting called by the E.J.C. were the American Association of Engineers, American Institute of Chemical Engineers, American Institute of Electrical Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Civil Engineers, American Society for Engineering Education, The American Society of Mechanical Engineers, American Society of Refrigeration Engineers, American Water Works Association, Institute of the Aeronautical Sciences, Institute of Radio Engineers, National Society of Professional Engineers, Society of Automotive Engineers, and the Society of Naval Architects and Marine Engineers.

The I.A.S. was represented by the Director, S. Paul Johnston.

Steve Zand Gives Paper at S.A.E. January Meeting

A paper of particular interest to aircraft design engineers will be presented by Dr. Stephen J. Zand, F.I.A.S., Vice-President in Charge of Engineering, Lord Manufacturing Company, at the annual meeting of the Society of Automotive Engineers in Detroit, January 9–13.

Entitled "Fatigue Life of Aircraft Engine Mounting Components," the paper is based upon fatigue data collected by the mounting manufacturer and the Air Materiel Command during development and test of the MR-40 Dynafocal Suspension for R-4360 engines.

Dr. Zand is best known for his developmental work on instrumentation, automatic flight control, and vibratory problems. Coauthors with him in the preparation of the paper are R. C. Henshaw and L. Wallerstein, Jr., of Lord Manufacturing Company.

C.A.A. to Aid Development of Agricultural Plane

Delos W. Rentzel, H.M.I.A.S. and Administrator of the Civil Aeronautics Administration, announced at the Annual Trades Association's Convention in New Orleans that in connection with plans for development of special aircraft for agricultural uses, the C.A.A. expects to use $50,000 for development work to be done at Texas A. & M. College.

In addition, Mr. Rentzel said, a parallel project for development of better dispensing equipments for dust and spray will be undertaken at the same place.

▶ **Not Competing**—Stressing that the C.A.A. was not going into aircraft production, Rentzel declared: "The C.A.A. definitely is not in competition with private industry. We have no intention of producing planes. We propose only to assist in the development of a prototype and then turn the design information over to manufacturers for use as they see fit."

Three More Firms Join Institute

Three new recruits to the growing ranks of I.A.S. Corporate Members are Telecomputing Corporation, 2901 Hollywood Way, Burbank, Calif.; Servomechanisms, Inc., Old Country and Glen Cove Roads, Mineola, L.I., N.Y.; and Airborne Accessories Corporation, 25 Montgomery St., Hillside 5, N.J.

▶ **Accurate Solutions**—Telecomputing Corporation is directed by a group of research engineers who, during the past decade, have been active in the foremost developments of aeronautics.

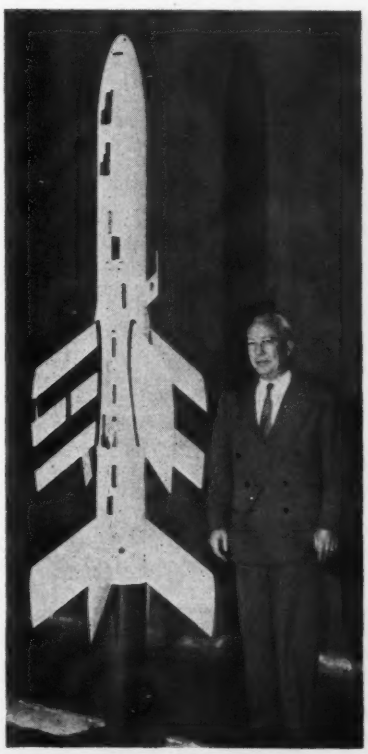
This broad experience qualifies their engineers not only to analyze and solve engineering problems by means of advanced computing techniques and automatic machines, but also to give assistance to corporation engineers in the development of industrial projects. The most modern mechanical and electronic I.B.M. computing machines are employed to assure the accurate solution of problems in a minimum of time.

Telecomputing Corporation designs, engineers, and manufactures research instruments and special automatic reading, counting, and plotting equipment to aid in the solution of engineering problems. This equipment is now available to the industry.

▶ **Servomechanic Specialists**—Servomechanisms, Inc., is producing for the Air Force and principal air-frame companies various items in the electromechanical field, specializing particularly in the application of servomechanics for precision positioning.

It also offers a unique packaging of electronic and mechanical equipment which has resulted in the design of units that permit high performance and great ease of maintenance. In addition, this design permits installation of these and similar units in military aircraft with high density factors because of their compactness and light weight.

The company at present employs about 100 people, including engineering staff, for development and production and is equipped with laboratories and facilities for production in



RYAN'S FIREBIRD AND SUTTON ◗

Harry A. Sutton, F.I.A.S., Director of Engineering, Ryan Aeronautical Company, is somewhat overshadowed by the Air Force's first air-to-air guided missile, Ryan Firebird, development of which he directed. Firebird is said to be one of most compact and "intelligent" high-speed flying weapons known. A rocket-propelled fragmentation shell which "homes" on its target by means of a radar navigational system, it is launched by a mother fighter or bomber in the direction of enemy aircraft, which the mother plane tracks by radar by day or at night or in bad weather. Missile carries a booster rocket for initial propulsion.

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The New ANGLgear

Now Available
ONE STANDARD MODEL
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Incorporating these features:

- Two-way and three-way units.
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accordance with government inspection and specification requirements.

▶ **Electromechanical Equipment**—Airborne Accessories is engaged in the development, manufacture, and sale of electromechanical and mechanical products.

The majority of these products are standardized units employed in the latest production and experimental aircraft. Modifications of these basic designs are also furnished for industrial purposes.

Trademarked products presently in production are: "Trim Trol," an electrical trim-tab control; "Rotorac," an electrical rotary actuator; "Lineator," an electric linear actuator; and "ANGLgear," right-angle drive units. Other similar products are under development.

A branch sales office is located at 6926 Melrose Avenue, Hollywood 38, Calif. Representation in Dallas, Texas, is by W. N. Wright and in Canada by the Ontario Hughes Owens Co., Ltd., of Ottawa.

Hebrew Technical College Thanks I.A.S. for Assistance

In a letter sent to Charles H. Colvin, F.I.A.S., Acting President S. Ettingen of Hebrew Technical College, Haifa, acknowledged receipt of three cases of technical books on aviation which were assembled by the Institute Librarian, Maurice H. Smith.

"The books," said President Ettingen, "are of particular value to us in connection with our plans for the Aeronautical Engineering Department."

Gifts to the Institute Collections

Four albums of air-mail covers were added to his previous gifts by John V. P. Heinmuller, including transoceanic and pioneer air-mail covers and an almost complete collection of Philippine Islands flown air-mail covers. A French lithograph in color, showing the dirigible airship "Republic" of about 1900, was among Mr. Heinmuller's gifts. Periodicals and books were added to his previous generous gifts by Horward A. Scholle. A blueprint of the Santos-Dumont "Demoiselle," giving complete measurements, was received from Karl K. Fairbanks. Two hundred and fifty N.A.C.A. reports were received from the Republic Aviation Corporation through the courtesy of Mrs. George Burrell. The Aeronautical Digest Publishing Corporation added 355 foreign periodicals, books, and reports to its earlier generous gifts. Dr. Alexander Klemin added 11 books to his previous gifts.

Additional gifts were received from Robert G. Averill; *Aviation Week;* British Joint Services Mission; California Institute of Technology; Chamber of Commerce of the United States; LeRoy V. Coburn; John C. Cooper; E. I. du Pont de Nemours & Co., Inc.; Hawaii Aeronautics Commission; International Air Traffic Association; International Organization for Standardization; The Johns Hopkins University; North American Aviation, Inc.; Research Information Service; Sperry Gyroscope Company; Telefonaktiebolaget L. M. Ericsson; United Aircraft Corporation through the courtesy of Robert C. Sale; University of California; University of Illinois; Wisconsin University; Wallace Barnes Company and the U.S. Bureau of Mines; Navy Bureau of Ordnance and Bureau of Ships; Central Air Documents Office; Civil Aeronautics Administration; Civil Aeronautics Board; David Taylor Model Basin; Forest Products Laboratory; Post Office Department; State Department; Congressional Committees on Appropriations, Armed Services, and Interstate and Foreign Commerce; and the Senate and House Document rooms.

I.A.S. Newslines

▶ Not So Gloomy . . . **Wellwood E. Beall,** F.I.A.S., Boeing Airplane Vice-President for Engineering & Sales, stated in a letter to air-line and Government officials that Britain's current lead in jet transports may not be so serious as first expected. Pointing out that British now are firmly committed to action on specific jet types, he said: "We believe we can take advantage of that fact if immediate action is taken to establish a program in this country which will provide the financial backing required to initiate prototype development and production," picking up where the British left off and bringing out an improved airplane.

▶ Doman Joins Ford . . . Former Vice-President and Chief Engineer, Aircooled Motors, **Carl Doman,** A.F.-I.A.S., who resigned last November 15, has joined the staff of L. D. Crusoe, Vice-President and General Manager of the Ford Division of Ford Motor Company.

▶ Urges Action on Jets . . . **James H. Doolittle,** F.I.A.S. and Vice-President, Shell Oil Co., strongly recommended all U.S. agencies interested in aviation—government and civilian—get together immediately to evaluate

America's present position and to plot course of action leading to development and construction of jet transports in U.S. Speaking in Kansas City, Mo., Doolittle said: "If it is determined that governmental assistance is necessary to start work now on the construction of America's jet air transports, that help should be provided." Only firm orders are needed to put existing drawing-board plans into action, he added.

▶ Patent Engineer . . . **Donald A. Hall,** A.F.I.A.S., who resigned from Convair as Preliminary Design Engineer, is with Byron Jackson Company, Los Angeles, as Patent Engineer.

▶ Airway Motors President . . . **T. P. Hall,** A.F.I.A.S., is President and Chief Engineer of Airways Motors, Inc., San Diego 3, Calif.

▶ Joins Oscar Fisher . . . Former Faculty Lecturer **Emil K. Harvey,** A.F.I.A.S., resigned from New York University's staff to join Oscar Fisher Company, Inc., as Assistant to the President. Company manufactures industrial-drying and air-conditioning equipment.

▶ New C.A.A. Manual 42 Available . . . **D. W. Rentzel,** H.M.I.A.S., C.A.A. Administrator, has announced a revised edition of Civil Aeronautics Manual 42, "Irregular Carrier Certification and Operation Rules." Revised manual interprets and explains requirements for irregular air-carrier operations specified in Part 42 of Civil Air Regulations. Copies are available from Superintendent of Documents, Washington 25, D.C., for $1.00 apiece.

'COPTER AIR RESCUE TEST

First test of air-rescue work to be conducted by McDonnell Aircraft Corporation for members of the Artic Rescue Helicopter Evaluation Board took place early in November at Lambert–St. Louis Municipal Airport. Using XHJD-1 "Whirlaway," called the world's first twin-engined helicopter, and one of the largest rotary wing aircraft, Air Force pilots flew the craft under supervision of Charles R. Wood, Jr., A.F.I.A.S., Chief Helicopter Test Pilot for McDonnell. Ralph Ballard, McDonnell mechanic, shown at the end of rope, was first to be "rescued" by XHJD-1. Note engine exhaust stacks at aft end of nacelles and hard-rubber tires on landing gear. Propulsive boost is obtained by exhaust stacks similar to those in Convair-Liner.

Corporate Member News

• Still Expanding . . . **Airborne Instruments Laboratory, Inc.,** Mineola, Long Island, N.Y., which has been expanding its facilities for the past year, is to occupy the entire 10,500 sq.ft. of space provided by a new 2-story building now under construction adjacent to its present site. Building has been leased on a 5-year basis for occupancy around February 1.

• $2,500,000 in New Business . . . **AiResearch Manufacturing Company** of Los Angeles has received new production orders for $2,500,000 worth of aircraft accessories since October 1. New business comes from approximately 40 different customers, including the military services, and is for 52 types of aircraft. More than $1,000,000 is for electrical actuators for 14 different types of planes. As of November 15, AiResearch backlog was about $13,-500,000.

• American Air Coach Service . . . Scheduled low-fare transcontinental air coach service by **American Airlines System** was to start December 27 with Douglas DC-4's seating 70 passengers. Converted 70-passenger DC-6's are to replace the DC-4's next spring. New York–Los Angeles fare is $110; Chicago–Los Angeles, $85; and New York–Chicago, $35 . . . C.A.A. authorization was granted American to use newly installed V.H.F. Omnidirectional Radio Range facilities on the airway between Walnut Ridge, Arkansas, and Tulsa, Oklahoma. American selected the Walnut Ridge–Tulsa airway because it conveniently separates navigational problems from those of traffic control. C.A.A. does not presently provide air-route traffic control service between these points, leaving American free to provide for its own aircraft whatever traffic control it feels is necessary . . . Eight-day vacation tour to Sun Country in Arizona, which sells for $98 and started last October 24, will be available to May this year on American Airlines. Sold through its reservations offices just like transportation, package covers finest food, accommodations, and activities, including riding, chuck-wagon picnics and pack trips, as well as golf, tennis, swimming, and organized social activities. Tour price is based on two persons to a room.

• Daily Stratocruiser flights across the Atlantic, which began November 15, marked an increase from four flights a week in **American Overseas Airlines'** schedules. At same time, company retired last of its DC-4's on Atlantic run. Seven Stratocruisers are in operation, and A.O.A. is retaining two DC-4's for service between Frankfurt and Berlin.

• Brazilian Beechcraft . . . One of the greatest single postwar orders for new planes negotiated by **Beech Aircraft Operation** with any one organization, a one-third-million-dollar contract, is represented by a fleet of four Beechcraft Twin transports and five Bonanzas, being readied for delivery to Brazilian Air Force. Planes will be used by Brazilian air transport command to maintain vital mail, passenger, and cargo services in remote and little-explored sections of the interior . . . Award of another Navy contract has upped Beech Aircraft Corporation's production backlog, adding some 491,000 man-hours of direct labor to winter and spring schedules. New contract calls for modification and overhaul of an additional 100 military twin-engined Beechcrafts. Reconversion work is anticipated to total about $3,000,000 when all work is completed.

• New Bell Feeder-Liner . . .Rapid large-scale transportation between congested metropolitan areas, outlying airports, and suburban sections moved one step closer with announcement by **Bell Aircraft Corporation** of its new Feeder-Liner, a helicopter capable of carrying a pilot and up to 12 passengers. Prototypes have been flying for three years. Engineered to use either a 600- or 800-hp. engine giving it a cruising speed of better than 100 m.p.h., big Bell helicopter has metal fuselage and can be equipped with conventional, 'copter wheels or amphibious landing gear. New model uses the single 2-bladed main-rotor system and other features of the firm's smaller 2- and 3-place helicopters.

• Bendix Products Expands . . . An extensive expansion program to care for increasing parts business that has upped in volume more than five times since 1947 will continue through 1951, **Bendix Products Division,** Bendix Aviation Corp., South Bend, Ind., reports. Floor space has been increased from 9,000 to more than 20,000 sq.ft., with a substantial increase in the number of salary and hourly rated employees. Administrative offices also have been enlarged.

• Boeing's Third Quarter Profit . . . Net earnings of $1,117,826 for the third quarter ended September 30 were declared by **Boeing Airplane Company,** bringing to $1,780,175 the total net earnings for first 9 months of 1949. Delivery of 57 planes—principally B-50's and air-line Stratocruisers—and other sales and income for the quarter amounted to $65,688,373, making a total of $176,513,510 for the 9 months. Company declared a dividend of $1.00 payable last November 24 to stockholders of record as of close of business November 8 . . . New Boeing B-50D Superfortress now is equipped with two 700-gal. streamlined external fuel tanks. Normal range of B-50 is more than 6,000 miles with 10,000 gal. of fuel. Same

579782

fittings used for external tanks can accommodate 4,000-lb. bombs. Big bomber has a speed of more than 400 m.p.h. and total bomb capacity of 28,000 lbs. Gross weight is 164,500 lbs. New radar and radio equipment, all-Plexiglas nose section, new top forward gun turret, and Boeing-developed single-point refueling system are other features of B-50D.

• Net profit of **Consolidated Vultee Aircraft Corporation** for quarter ended August 31, 1949, amounted to $1,112,558. For first 9 months of the fiscal year, net profit was $2,697,885. In like period in fiscal year 1948, a net loss of $8,109,139 was registered . . . Air Force contract for twelve additional T-29 navigational trainers was awarded Convair, amounting to approximately $5,200,000 for planes and spare parts. Total T-29 order now is for 48. First T-29 made initial flight September 22, 1949. Delivery of first completed trainer is scheduled for early this year.

• Douglas DC-6B . . . As a companion plane to its new high-performance DC-6A Liftmaster cargo carrier, **Douglas Aircraft Company** has a larger, faster, and more powerful DC-6 passenger liner, the DC-6B. Equipped with new P & W R2800-CB17 engines providing 1,600 more take off hp. than before, DC-6B will carry more passengers (64 total) than standard DC-6. New plane has top speed of 360 m.p.h. Average speed of 316 m.p.h. is indicated for overocean ranges up to 3,560 miles with 54 passengers instead of the present 48. Douglas says this offers 14 per cent greater passenger capacity for only 4 per cent increase in operating costs. Five feet of additional fuselage length is provided. In addition to the finely appointed DC-6B, a high-density 92-passenger version of the new series also is available in a coach-fare type of interior or in convertible cabin combining passengers and cargo in variable proportions. Take-off gross weight of 100,000 lbs. and landing gross of 85,000 lbs. remains the same as with DC-6A . . . C.A.A. has approved use of Skydrol, fire-resistant hydraulic fluid developed jointly by Douglas and Monsanto Chemical Company, in scheduled passenger airplanes. In addition to being cleared for use throughout the high-pressure hydraulic systems of both DC-4 and DC-6 transport planes, specific approval also was given for Skydrol to be used in cabin superchargers of the DC-6. Upon completion of current development work, C.A.A. is expected to approve Skydrol for use in other types of aircraft.

• Eastern Transfers to Miami . . . **Eastern Air Lines, Inc.,** began transfer of five of its departments from New York and Washington to its Miami Base headquarters in middle of October when Ready Reference Guide department left temporary quarters in Washington National Airport to Florida. It was followed by the Passenger Service department, Addressograph Section, Air Mail and Air Parcel Post department, and Sports Events and Military Travel Section from New York office at 10 Rockefeller Plaza . . . Four cents a mile air-coach operations between Chicago and Miami were to go into effect last December 15 on Eastern's schedules. Douglas DC-4's operated by regular Eastern crews are being used.

GLOBEMASTER GAPE

Huge clamshell doors in nose of C-124 Globemaster II, which came out of Douglas Aircraft Company's Long Beach plant on November 11, provide an opening 11 ft. 8 in. high and 11 ft. 4 in. wide. Built-in ramp permits wheeled vehicles to drive or be rolled into the cavernous fuselage having more than 10,000 cu.ft. of usable cargo space. The single-deck unobstructed cabin is 12 ft. 10 in. high, 13 ft. wide, and 77 ft. long. Loading and unloading are facilitated by an electrically operated elevator that can be lowered to the ground from the center cargo section. As personnel carrier, interior of the C-124 may be converted into a double-deck cabin with a capacity for 200 troops and their field equipment, or, as air-borne hospital, it accommodates 136 stretcher patients, plus 52 attendants or ambulatory patients. Powered by four P & W R-4360-20W engines, with water injection and two-speed superchargers, rated at 3,500 hp. (takeoff), Globemaster is expected to fly about 50,000 lbs. of pay load a distance of 850 miles, unload, and return to base without refueling. Air Force has ordered 29 production C-124's from fiscal 1949 funds.

• Development of new remote-reading ultra-high gas-temperature indicator has been announced by **Fairchild Camera & Instrument Corporation,** West Coast Division, 53 West Union St., Pasadena, Calif. Designated Fairchild Model 263 Gas Temperature Indicator, instrument provides convenient and extremely accurate method for measuring gas temperatures to more than 5,000°F., company says. Operating principle is based on well-established equations for gas flow through a metering orifice. Proper solution of these equations by the instrument permits obtaining gas temperature to high degree of accuracy, Fairchild claims. Sample of gases is obtained by means of water-cooled stainless-steel probe, which may be manipulated to obtain a temperature traverse of gas stream under test.

• Fairchild Dividend . . . A dividend of $0.35 per common share was paid December 5 to stockholders of record November 17 by **Fairchild Engine & Airplane Corporation.** Totaling more than $800,000, dividend was largest single payment ever made to stockholders in Fairchild history. Present corporation backlog exceeds $70,000,000 in unfilled orders, covering procurement by Air Force and Navy of 144 C-119's, an undisclosed number of guided missiles, and aircraft power plants, and ordnance contracts on special military projects . . . More than $500,000 worth of Stratos aircooling and pressurizing units were sold to American Airlines for its entire Convair-Liner fleet, marking first major sale of corporation products in commercial field . . . Fairchild reports it is well along on its research and development program to develop an atomic-powered engine for aircraft.

• New G-E Aircraft Instruments . . . Two hermetically sealed aircraft instruments that indicate position of wheels, flaps, trim tabs, cowl flaps, and other components have been announced by **General Electric Company,** Schenectady, N.Y. Available in two models, new d.c. selsyn position indicators are designed to meet Air Force–Navy specs. Model 8DJ51GAB is new-type landing-gear position indicator that can be used to replace position lights now commonly used. Model 8DJ48AAD, a round-case instrument, indicates flap position in a plane regardless of degree of flap travel. Modifications of this model can be furnished which indicate position of tabs, cowl flaps, etc.

• Jet Target Plane Award . . . **Globe Corporation,** Aircraft Division, of Joliet, Ill., has been awarded a production contract by Navy, BuAer, to manufacture a sizeable quantity of pulse-jet-powered pilotless aircraft targets for use in training Navy gunners. Target aircraft is designated Navy KD2G-2 and will be powered by pulse-jet engine similar to type used on V-1 missile and Navy Loon.

• A new reversing Hydromatic prop designed especially for the Lockheed L-749A Connie has gone into production at **Hamilton Standard,** Division of United Aircraft Corporation. Fifteen ft. in diameter, the three-bladed Hydromatic gives improved take-off and climb performance to match Constellation's increased weight of 107,000 lbs.

• Cast Iron That Bends . . . Industry now has available to it a new cast iron which unlike ordinary cast iron, is not brittle but can be bent or twisted. Made readily and economically, new material can be used in a myriad of applications, thus affording countless economies throughout the industrial world, says **The International Nickel Company, Inc.,** 67 Wall St., New York, N.Y. Known as ductile cast iron, it has several times greater strength than the ordinary cast iron, with greatly increased ductility and shock resistance. Granted patents for the inventions, International Nickel says essential feature is introduction into, and retention by, the molten iron under treatment of a small but effective amount of magnesium. Presence of critical amounts of magnesium in the cast iron produces a new graphite structure that is in the form of spheroids or compacted particles. More than 40 companies in many industries are now licensed to produce the new development.

(*Continued on page 16*)

F-3D SKYKNIGHT

guardian of the stratosphere

This new Douglas-built Navy fighter is the first all-jet airplane designed specifically for stratosphere performance. It has the speed, range and altitude required for upper-altitude fighting or long-range patrol and reconnaissance. The F-3D has been thoroughly tested and is now in production for the Navy at Douglas El Segundo, birthplace of the famous AD series and other dependable military aircraft for 17 years.

EL SEGUNDO PLANT OF

DOUGLAS

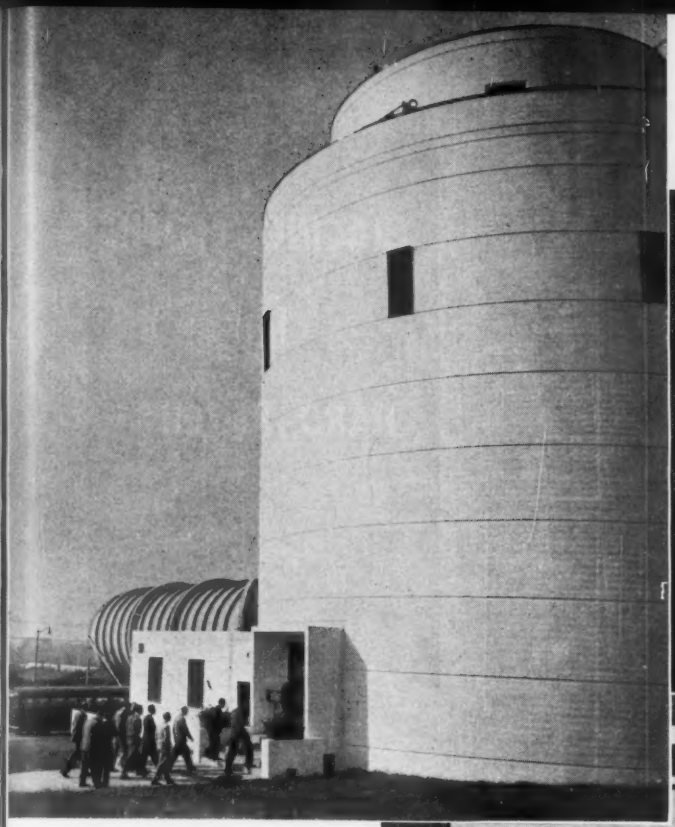
One hundred and seventy-two select and security-cleared representatives of I.A.S. Corporate Member companies visited Wright-Patterson A.F.B. in October at the invitation of Lt. Gen. B. W. Chidlaw, Commanding General of the Air Materiel Command. An inspection tour of the principal laboratories and a fly-by demonstration of the Air Force's latest equipment highlighted the two-day program.

Shown here are a few randomly selected pictures taken during the laboratory visitations and the Military Aeronautics Meeting dinner held at the Dayton Biltmore Hotel on October 27.

(Above) *Entire group leaving the Area A auditorium.* (Left) *One group visits the Power Plant Laboratory, while another* (bottom left) *sees a demonstration in the Propeller Lab.*

(Below) *George (capable "Mr. Fixit") Andrews, civilian P.I.O. representative of the A.M.C., on the flight line with I.A.S. Director, S. Paul Johnston.*

NATIONAL MILITARY AERONAUTICS MEETING
Dayton, Ohio—October 27, 28, 1949



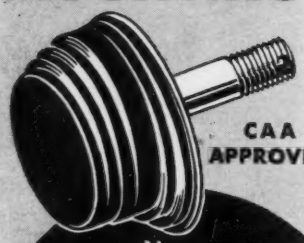
(Above) *The imposing Spin Tunnel.* (Right) *Colonel Harvell, Chief of the Equipment Laboratory, gives a few pointers on recent developments in aircraft equipment.* (Below) *A group studies the layout chart of the Power Plant Laboratory.*

(Top, right-hand photo) *At the Military Aeronautics Meeting Dinner, John F. Victory, Executive Secretary of N.A.C.A., formally presents the permanent plaque of the Collier Trophy to Capt. Charles Yeager. Captain Yeager, one of the three-man team winning the Award for 1948, was cited for his flight testing of the supersonic XS-1 research airplane.*

Improved

DC-4

ENGINE MOUNTING



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New LORD Dynafocal Core Delivers Smoother Performance ..... Longer Service Life

The *new* LORD MR-26-1B Dynafocal Core is now available. DC-4 operators should specify this superior core for replacements. Here is why.

- Increased Service Life.
- Increased Protection Against Metal-To-Metal Bottoming.
- Increased Passenger Comfort.
- Less Frequent Replacement.
- Lower Maintenance Cost.
- Directly Interchangeable With Those Now In Use.

MOUNTINGS FOR EVERY AIRCRAFT NEED

For any type of aircraft, or any aircraft application, LORD can supply the Mountings you require. Our specialized knowledge and experience in Vibration Control is at your service.

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Engineered Vibration Control

• Altitude Controller . . . **Kollsman Instrument Division,** Square D Company, has produced a new altitude controller, an aneroid actuated mechanism that controls the automatic pilot when corrections in the flight path are required to maintain selected altitude. Weighing only 25 oz., new instrument has such low friction that under flight conditions it is responsive to as little as 2 ft. of altitude change . . . Another new instrument, the Airspeed Controller, also has been developed at Kollsman and will be available shortly. A sister mechanism to the Altitude Controller, it will control air speed in a manner similar to that of the Altitude Controller.

• Air Force has let production contracts for autopilots and gyro indicating instruments to **Lear, Inc.,** Grand Rapids, Mich., culminating 5 years of development work by company in conjunction with Equipment Laboratory of Air Materiel Command. Designated F-5, the auto-pilot has been personal project of William P. Lear, A.F.I.A.S., who has been test flying various versions and development models continuously since early in 1945. It is scheduled for installation in the Northrop F-89 Scorpion. Basic mission of the device is to reduce pilot fatigue The vertical gyro indicating system is an instrument sometimes referred to as remote-reading attitude gyro or remote-reading artificial horizon and is to be installed in the B-36.

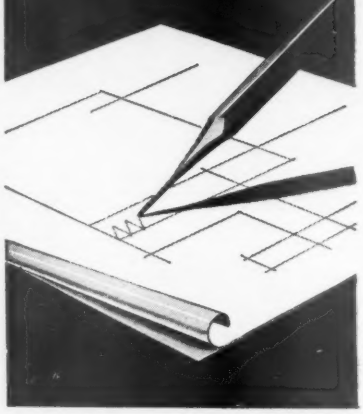
• Paper Available . . . **Lord Manufacturing Company,** Erie, Pa., will be glad to fill requests for copies of a paper, titled "The Characteristics of Elastomers with Respect to Vibration in Aircraft," by William A. Keetch, Senior Product Engineer, Lord Manufacturing.

• Unification . . . XB-51, newest and one of the most radical in design of Air Force's jet aircraft, has been testing at Patuxent River Naval Air Test Station. Product of **The Glenn L. Martin Company,** the three-jet ground-attack bomber was to return to the Martin plant for further flight testing after a number of flights at Patuxent River.

• Radar Trouble-Shooting . . . Unique device that can quickly trouble shoot highly sensitive radar wiring on Air Force bombers is reported by **North American Aviation, Inc.,** Los Angeles. Testing equipment, known as a continuity and megger checker, can cut down time required to check radar wiring in a North American B-45 from 360 man-hours to 8. Air Force has ordered 29 for use on other-type bombers and has received first unit. By running 500 volts through the normal 24-volt radar system, "leaks" that normally would be difficult to locate can be found immediately with new checker.

• Unusual Canopy . . . High-speed planes require the cockpit bubble be kept as small as possible, yet large enough to admit the pilot and to permit ground crew to gain rapid access to equipment carried in foreward part of body nacelle. In addition, fastening problem of small canopy presents its quota of trouble to design engineers. **Northrop Aircraft, Inc.,** engineering team successfully solved these problems with unusual canopy design on Northrop X-4 research plane. In X-4, plastic bubble was made as small as practicable

TRACING CLOTH for HARD PENCILS



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and attached to a fuselage section. Then fuselage section was hinged at aft end to fuselage. When closed, positive locking fasteners clamp it securely in place. Cockpit also is said to be more easily jettisoned for emergency bailout . . . Pointing out that consideration is being given the possibility of ordering additional Northrop Scorpion F-89 all-weather interceptors, Air Force instructed Northrop Aircraft to discontinue modification of eight Flying Wing B-35 bombers to jet propulsion. Only one prop-driven Wing is to be modified into a six-jet YRB-49 photo-recon bomber "to permit the Air Force to evaluate further the Flying Wing design." Seven of the discontinued bombers were to be modified into six-jet YB-35's. Eighth was to have been used as flying test stand for Northrop-developed Turbodyne designed to produce 10,000 hp. Cutback decision of Air Force has resulted in the layoff of more than 500 at the Northrop plant in Hawthorne and an additional suspension of work at company's subsidiary, The Turbodyne Corporation.

• Round World in Five Days . . . A trip round the world in less than five days by scheduled air liners is latest in air transport news. **Pan American World Airways'** newest round-the-world schedules, in effect since November 1, cut 26 hours off previous best time. Pan Am Clippers now make trip from New York to San Francisco in 4 days, 13 hours. Formerly, schedule called for 5 days 15 hours. Constellations are used between New York and Hong Kong; DC-4 Sleeperette Clippers carry on from Hong Kong to Manila; and Stratocruisers take it from there to Los Angeles via Guam, Midway, and Honolulu . . . A 4,900-lb. stone crusher, pronounced too heavy to ship by boat, was picked up and toted by Clipper from Miami to Havana recently . . . Convair-Liner Clippers went into service with Latin American Division on November 4, serving British West Indies, Virgin Islands . . . Air-to-ground communication by radio telephone is now being used by Pan Am Clippers flying between Shannon, Ireland, and Basra, Iraq, replacing dot-dash radio-telegraph system . . . Cargo Clippers picked up 45,000 lbs. of tires from B. F. Goodrich plant in Akron and flew them to Goodrich's Havana branch plant, record international shipment of car tires by air.

• Wasp Major Production . . . The 4,000th Wasp Major engine to be produced by **Pratt & Whitney Aircraft** division of United Aircraft Corporation left the East Hartford plant last November. First one built—still called "old X-101"—was rolled into a test cell on April 28, 1941, for a 10-min. run. An advanced model of the 3,500-hp. Wasp Major has passed an official 150-hour qualification test at considerably more than 4,000 hp . . . P & W again had fewer lost-time accidents during first three quarters of 1949 than other aircraft engine manufacturers in the country, according to figures released by National Safety Council. With only 3.6 lost-time accidents for each million man-hours worked during the period, company's frequency rate was only slightly more than half of 6.5 average for all aircraft-engine manufacturers . . . New $12,000,000 laboratory, designed and built expressly for test of experimental jet engines by Pratt & Whitney, is to be named the Andrew Willgoos Turbine Laboratory, after late Chief Engineer. P & W saved considerable sum through purchase of power-generating equipment. Four boilers, on the way to a Philadelphia junkyard after the war, were found and bought by P & W purchasers who got them for fraction of cost of building new ones. Similar discounts were yielded on twelve turbogenerator sets by six returned lend-lease war-surplus destroyer-escort vessels.

• Republic Profits . . . A net income, after taxes, of $414,100 for 9 months ended September 30, 1949, was declared by **Republic Aviation Corporation.** This amount is also after provision for contingency reserve of $180,000. Sales for the period totaled $26,597,503—backlog of orders, $49,000,000.

• Skyrocketing Navion Performance . . . Using Jato Juniors, **Ryan Aeronautical Company** sales demonstration pilot William P. "Doc" Sloan took off in a Navion recently; reported: "I had over a 1,000 ft. before I could even get the gear up!" Developed by Aerojet Engineering Corporation, Jato Junior, still restricted by Navy classification, is not yet commercially available.

• Net earnings of $1,296,284, or $1.00 per share of capital stock, for first 9 months of 1949 were reported by **Stewart-Warner Corporation.** In 1948, net earnings were $2,609,725 or $2.02 a share for like period. Sales for 1949 were down 27.8 per cent for the 9 months, compared to sales of $55,-993,599 for same period in 1948.

• Test Actuator Lubricant Performance . . . A method of testing lubricant performance on aircraft actuators used to move wing and cowl flaps, trim tabs, and landing gears has been developed in the Beacon, N.Y., laboratories of **The Texas Company.** New test enables lubrication engineer to prove what lubricants are suitable to aircraft actuator use, how long such lubricants will last in actual service, and what causes their breakdown. Basic equipment for new test technique is composed of an air-loaded cylinder and an electrical system consisting of two solenoid valves, a timer, d.c. motor, voltmeter, and ammeter. Technique was worked out with assistance of AiResearch Manufacturing Company.

• Speed Nuts in Cars . . . George A. Tinnerman, Vice-President of **Tinnerman Products, Inc.,** speaking before the American Society of Body Engineers in Detroit on November 3, said that car makers have accepted the Tinnerman Speed Nut brand of fasteners because of their superior performance and economy. "If you can save 54.707 cents a car in fastening it together more securely and efficiently," said Tinnerman, "the auto industry is glad to do business with you." Study of the application of Speed Nut fasteners in eight different operations showed that 22.939 cents was saved in material costs and 31.768 in labor and overhead. Approximately 60 per cent of the savings resulted directly from elimination of material handling.

• Upsurge in U.A.L.'s Air Cargo . . A strong upsurge in air-cargo shipping, apparently reflecting brisk fall and pre-Christmas buying as well as nationwide industrial activity (before the strikes in steel and coal), was reported by **United Air Lines, Inc.** Company had increases of 5½ per cent in September over preceding month, and 12½ per cent over a year previous. First 2 weeks in October showed 10 per cent increase over same period in September and 25 per cent over first 2 weeks in October 1948 . . . Ultra-modern control tower at Reno, Nev., airport is expected by United's engineers to set pattern for future installations of similar size and scope. Constructed by U.A.L. and operated by C.A.A., compact tower includes soundproofing, air conditioning, polarized angled windows to eliminate glare, and V.H.F. receivers and transmitters on all frequencies for contact with private, military, and commercial planes. Counter device keeps daily totals of all planes using the field. Phone facilities link tower directly with those in Sacramento and Oakland and, via relays, with others in the C.A.A.'s western circuit.

• 1,000th Jet Engine . . . A J-34 (24-C) jet engine recently installed as one of the twin power plants of a McDonnell F2H Banshee shipboard fighter, was the 1,000th engine to roll off **Westinghouse Electric Corporation's** production line . . . A dividend of $0.65 a share was declared on company's common stock, payable last December 1 to stockholders of record November 14. Total payments for the year were $1.40.

• Cyclone 18BD Production . . . **Wright Aeronautical Corporation** has sold 508 Cyclone 18BD engines for installation in latest Lockheed Constellation air liners. Total number of engines for these planes, including spares sold directly to the air lines, reaches 849, and current orders will keep this type of engine on the assembly lines until at least August, 1950. First four "BD" engines were sent to Lockheed in February, 1946.

I.A.S. Sections

Chicago Section

Alfred Stall, *Secretary*

On November 8 the Section enjoyed two speakers: Harold V. Hawkins, Chairman, and Professor of Civil Engineering, Illinois Institute of Technology; and Harry Stiles, Acting Chief, Air Route Traffic Control, 3rd Region, C.A.A.

▸ **O'Hare Airport**—Mr. Hawkin's talk covered the development and future plans of O'Hare Field, Chicago's new airport.

In addition to construction problems, he described the methods of handling traffic so that eventually the airport will be able to handle 360 movements per hour. The newly designed adjustable passenger ramps de-

Meet Your Section Chairman

Archie Trescott Colwell

Cleveland-Akron Section

Vice-President of Thompson Products, Inc., Archie Trescott Colwell is a West Point graduate, serving with the U.S. Army Engineers from 1918 to 1922, when he went on inactive-duty status as a Captain in the Officers Reserve Corps. On leaving the Army, he joined Thompson Products where he has remained ever since, being appointed Chief Engineer in 1929.

▶ **Valve Development**—Mr. Colwell, who was born 54 years ago at Yankee Jims, Calif., is noted for his development of valves, valve-seat inserts, piston rings, and valve-retainer locks for aircraft and automotive power plants.

During the late war, he served on the Board of Directors of the War Production Board and on the Central Aircraft Council, War Engineering Board, Society of Automotive Engineers.

Among his published papers in the *S.A.E. Journal* are: "Turbine Engine Blading: Manufacturing Technique and Fastening Methods," "More Effective Utilization of High-Octane Fuels," and "Corrosion-Resistant Metals for Valves and Seats on Heavy-Duty Engines."

He also has presented papers before the S.A.E. and American Petroleum Institute meetings, including "Powering Our Future Cars" and "Alcohol-Water Injection" before the S.A.E. and "Lubricant Requirements for the Automobile Engine of the Future," which was delivered before the A.P.I.

Mr. Colwell, who is married and has two children, likes to relax on the golf course or by taking color pictures.

scribed by the speaker make it possible to load and unload passengers without exposing them to the weather. He also explained the financing plan.

▶ **Traffic Problems**—Mr. Stiles discussed the traffic problems confronting the development of O'Hare Field. He explained the VOR (Visual Omni-Range) equipment course-line computor, distance-measuring equipment, as well as many other new navigational aids. His talk was supplemented with an illustrated sound recording entitled "Advancing Air Navigation."

Cleveland-Akron Section

William A. Fleming, *Secretary*

A dinner meeting was held October 25 with Vice-Chairman Dr. R. S. Ross, from Akron, presiding. Sixty members attended the dinner and 70 attended the meeting.

▶ **Engineering Progress** — "Forty Years of Aeronautical Engineering" was the subject presented by Thomas Knowles, Vice-President and General Manager of Goodyear Aircraft Corporation.

Mr. Knowles discussed the progress in the field of aeronautical engineering in the last forty years. He described the constant battle against weight in both heavier and lighter-than-air craft. He also covered the adaptability of old ideas in new form for current aircraft, and new equipment and techniques that have been developed.

A large portion of the paper dealt with the possibilities of lighter-than-air craft in the present and future.

Hagerstown Section

James M. Crook, *Secretary*

One hundred and three members, wives, and guests attended the October 26 dinner meeting at the Fountain Head Country Club.

After the dinner, Herman Wieben, outgoing Chairman, explained the purposes of the I.A.S. for the benefit of nonmembers present. Following the reading of the financial statement for the fiscal year 1949, Mr. Wieben introduced the new officers. Dan Weller, new Chairman, made a brief acceptance speech.

▶ **New Officers**—Incoming officers and committee appointments were as follows: Chairman, Dan Weller; Vice-Chairman, Hank Sieradzki; Secretary-Treasurer, Logan Waterman; Area Nominating Committee Representative, Mel Cawl.

- **Advisory Council**—A. J. Thieblot, R. W. Lessard, H. Wieben, R. I. Markey.
- **Program Committee**—Bill Maloney, Chairman; Dutch Gelvin, Henry Reisner, Earle Stewart.
- **Membership Committee**—Bob Gilson, Chairman; Bob Braus, Hank Andrews.
- **Social Committee**—Jim Gibson, Chairman; Alex Petrides, Ted Hoffacker.
- **Technical Advisory Committee**—Bob Darby, Chairman; Jim Crook.
- **Publicity Committee**—Hank Billings, Chairman; Lyle Lutton.
- **Activities Committee**—M. J. Frank, Chairman.

Speaker of the evening, D. Roy Shoults, formerly of The Glenn L. Martin Company, spoke on "Producibility and Modern Aircraft Design." His talk centered mostly round the problems encountered in the designing and manufacture of jets and other late-type aircraft.

Los Angeles Section

E. P. Hartman, *Secretary*

A joint meeting was held October 13 with the Aviation Instruments Committee, Industrial Instruments and Regulators Division of the American Society of Mechanical Engineers.

Held in the new I.A.S. Western Headquarters Building, the meeting represented the first of a series of "specialist" meetings planned by the Section. Attendance was about 100, with R. E. Rogers, A.S.M.E. member and chairman of the A.S.M.E. Instruments and Regulators group, presiding.

▶ **Compensated-Float Gage**—First of two papers presented was "Compensated-Float Liquid-Level Gages for Aircraft," by R. G. Ballard, Division Engineer, General Electric Company, read by C. F. Van Bennekom, Design Engineer of G-E's West Lynn plant.

The compensated-float gage described in the paper represents a new application of the old principle of the battery hydrometer—i.e., the height at which a float will ride is a function of the specific gravity of the fluid in which it is immersed.

As used in the gage, the float is attached to a pivoted arm having 90° of motion. Position of the arm is measured by a variable-capacitance pickup unit that registers on a suitable dial. Position of the float in the tank is a function of both the volume and density of the fluid present. The gage actually measures the mass of the fluid present rather than its volume, and, according to the paper, it performs this function with considerable accuracy. In tests made with both water and kerosene (considerably different densities), the gage measured the mass of the fluid with an error of not more than 1 per cent.

▶ **New Meters**—The second paper, "The Development of a New Type of True Air-speed and Mach Number Meter," was delivered by its author,

F. H. Gardner, of G. M. Giannini & Co., Inc., Pasadena.

As described by Mr. Gardner, the true air-speed meter and Mach meter make use of a standard pitot-static head in conjunction with a temperature probe of high recovery factor. Electric signals produced by the pressure bellows of the air-speed instrument and by the temperature probe are introduced into a self-balancing a.c. bridge circuit.

The servo motor, which performs the bridge-balancing function, also drives a pointer to show either true air speed or Mach Number. Throughout a wide range of air speed and altitude, the Mach Number error of the instrument was shown by the speaker to vary from 0.001 to 0.008. In most cases, the error was in the neighborhood of the lower value.

The error in the true air-speed indicator was less than ±2 knots at speeds up to 450 knots, and less than ±3 knots at speeds from 450 to 600 knots.

Washington Section

Bernard Maggin, *Secretary*

At the November 15 meeting, a paper on "High Speed Aerodynamic Research Using Rockets" was presented by David Stone, Aerodynamic Research Scientist of the N.A.C.A. Langley Laboratory. Dr. Hugh L. Dryden, Director of N.A.C.A., was Honorary Chairman.

▶ **New Officers**—Milton B. Ames, retiring Section Chairman, introduced the new officers: Chairman, John Geisse, C.A.A.; Vice-Chairman, William H. Miller, BuAer, Navy; Secretary, Bernard Maggin, N.A.C.A.; and Treasurer, Charles D. Auld, David Taylor Model Basin.

Mr. Stone's paper was concerned with current techniques used by the Pilotless Aircraft Research Division of the Langley Laboratory to obtain aerodynamic data, using rocket-powered models, through the high subsonic, transonic, and into the supersonic realm. Dr. Dryden introduced the paper with a brief history of the Pilotless Aircraft Division and the Wallops Island, Va., research station where the rocket-powered model flights were made.

▶ **Techniques Used**—Mr. Stone described the techniques used in obtaining the drag data at zero lift, static and dynamic longitudinal stability and control data through a range of lift coefficients, and static and dynamic lateral stability and control data. Control data obtainable include not only control effectiveness but also control hinge-moment characteristics.

From the dynamic tests, basic dynamics of the configuration—as well as various damping coefficients—can be determined.

Slides illustrating methods used to obtain flight-test data accompanied the talk, and a motion picture showing aerial views of Wallops Island installations and records of launchings and flights of models was shown.

Wichita Section

H. E. Dickard, *Secretary*

Results of the annual election were as follows: Chairman, Marvin J. Gordon; Vice-Chairman, Douglas C. Heimburger; Secretary, H. Delmar Chitwood; and Treasurer, Robert W. Burnham.

REAPPOINTED BY N.A.C.A.

John Jay Ide, who represented the National Advisory Committee for Aeronautics in Europe from 1921 to 1940, has been reappointed Technical Assistant in Europe with offices in Paris. He left for his post on November 15. Ide served in the Navy from 1940 to 1947 and is a Captain, U.S.N.R. Among his assignments overseas were those of Technical Air Intelligence Officer of the Twelfth Fleet and Assistant Naval Attaché for Air at the American Embassy in London.

News of Members

Serge Alexeeff, M.I.A.S., is Structural Engineer for American Power Jet Company, Montclair, N.J. He was with Cancargo Aircraft Manufacturing Company Ltd., Montreal.

M. W. Beardsley, M.I.A.S., 9641 Santa Monica Blvd., Venice, Calif., is Engineering Consultant.

Kenneth J. Bigelow, M.I.A.S., is Liaison Engineer for Contract Administration Division, Solar Aircraft Company, Des Moines, Iowa.

Dante A. Cottone, T.M.I.A.S., is Data Analyst (Aerodynamics & Flight Test), Grumman Aircraft Engineering Corporation, Bethpage, L.I., N.Y.

Arthur F. Deming, M.I.A.S., has moved from Avalon Village, Wilmington P.O., Del., to 15823 Marlin Place, Van Nuys, Calif. He is Consulting Engineer with Hughes Aircraft.

Henry Fiedler, M.I.A.S., former President of Fiedler & Schmidt, Inc., Chicago, now is Chief Engineer, Hannaford Aircraft Company, Inc.

Wallace M. Frei, T.M.I.A.S., is Flight Test Engineer, Civil Aeronautics Administration, Park Ridge, Ill. New address is 707 S. Elmhurst Ave., Mt. Prospect, Ill.

Leonard S. Ganz, T.M.I.A.S., formerly Vibration Engineer at Piasecki, now is Field Service Engineer for Sperry Gyroscope Company, Great Neck, L.I., N.Y. Home address is 251 Ft. Washington Ave., New York 32, N.Y.

F/O J. C. Henry, R.C.A.F., T.M.I.A.S., has been posted to 426 Squadron, Dorval (Montreal), where he is flying Canadair North Star transports. He intends to get 2-3 years' piloting experience before entering the technical branch of the R.C.A.F. as an Aeronautical Engineer. New address: C/o Officers' Mess, 2675 Station Blvd., Lachine, P.Q., Canada.

Elliot G. Hill, T.M.I.A.S., is with the Stephens-Adamson Manufacturing Company as Development Engineer.

Dr. Bertil H. T. Lindquist, T.M.I.A.S., is Vice-President in Charge of Engineering & Research, Norman Chemical Company, St. Paul. Dr. Lindquist also has his own consulting business.

Dorr Lobrecht, T.M.I.A.S., former Graduate Student of Texas A. & M., is now with Consolidated Vultee Aircraft Corporation, in the Ordnance Aerophysics Laboratory, Daingerfield, Texas.

Kenneth Mann, M.I.A.S., is now Aerodynamics Engineer, Hughes Aircraft Company, Culver City, Calif.

Richard L. Montoney, T.M.I.A.S., is a Mechanical Engineer for the Arabian American Oil Company, Dhahran, Saudi Arabia.

R. T. Nalle, Jr., M.I.A.S., who is in the Aviation Gas Turbine Division of Westinghouse Electric Corporation, has been transferred to Kansas City, Mo.

Frank P. Nelson, T.M.I.A.S., is Aerodynamicist B, Douglas Aircraft Company, El Segundo, Calif. Home address is 5855 W. 88th St., Los Angeles 45, Calif.

Paul W. O'Meara, M.I.A.S., former Production Design Engineer, Curtiss-Wright Corporation, now is Aeronautical Production Engineer, Air Materiel Command, Wright-Patterson A.F. Base, Dayton, Ohio.

C. C. Pearson, M.I.A.S., President and General Manager and a Director of The Glenn L. Martin Company, has been

(*Continued on page 64*)

Editorial

To Bill Burden—In Appreciation

There are men who make great contributions to the cause of the aeronautical sciences who themselves are not aeronautical scientists in the commonly accepted use of the term. The Guggenheims are certainly in that category, as are half a dozen others whose names come readily to mind. Close to the top of that list would be found the name of our retiring president—William A. M. Burden.

Bill Burden would be the last to claim for himself any facility with triple integrals or slide rules. No airflow theorem bears his name, nor is it likely that he will ever design a supersonic missile. But Bill Burden, by his broad grasp of public affairs related to aviation development at home and abroad, by his long-standing interest in the human factors that lead toward aeronautical progress, and by his direct support of technical information services in the Institute and elsewhere, has wielded a profound influence on all those who deal in aeronautical research, aircraft engineering, and air-line operation. His contribution has furthered engineering progress by providing the essential tools with which we, as engineers, do our work.

He has been a staunch supporter of the Institute from its inception. As a member, as an officer, and as a member of the Council, he has been more than generous with his gifts, his energy, and his wisdom to make the Institute strong and to develop its services to the full.

Under his leadership in the year just closed, the I.A.S. has gone steadily ahead in all areas. Presiding over the Council, he has given us continuously the benefit of his broad business background and his extensive experience in public affairs. As official host to the Royal Aeronautical Society during the Second International Conference last Spring, his unfailing tact and courtesy did much to cement the bonds of good will which now unite the two great aeronautical societies of the world.

The Officers and Members of the Institute owe Bill Burden a rising vote of thanks for the contribution that he made to the general welfare and progress of this organization during his term of office. As a member of the Council, and of the Executive Committee during the coming year, he will continue to give us the benefit of his advice on I.A.S. affairs.

Elsewhere in this issue is the announcement of the election of our new president for 1950, J. H. Kindelberger. This is a particularly happy choice in view of the greatly increased activity in our western region centering about the Los Angeles Headquarters and the San Diego section facility. As he takes over the gavel from our new Past-President, we all pledge to him our support and cooperation in the work for the coming year. His is a worthy addition to the list of great names in aviation that have preceded him as President of your Institute.

S. P. J.

William A. M. Burden, retiring President of the Institute. His successor is James H. Kindelberger, who will be inducted into office at the Honors Night Dinner, January 23.

The Establishment and Measurement of Critical Requirements for Safe Flight in Transport Aircraft

THOMAS GORDON*
University of Chicago

I have been asked to present a brief outline of a research program, sponsored by the Committee on Aviation Psychology of the National Research Council with Civil Aeronautics Administration funds and conducted by the American Institute for Research, a nonprofit personnel research organization. When I began planning this presentation, it occurred to me that our project has its parallel in engineering research, a field that is probably more familiar than psychological research to most of you here. Our problem has been to develop an improved procedure for measuring pilot proficiency. It seemed to me, however, that what we have done in this program can be likened to what a group of engineers might do when faced with the problem of developing an improved instrument for measuring some variable, such as the altitude at which a plane is flying. Admittedly, however, psychological research of this sort is less precise than engineering research, but their methods can be compared.

Consequently, throughout this paper I shall stress the parallelism between these two research projects. It is my hope that showing our specific psychological research program in relation to a specific engineering research program will make the presentation of the former more meaningful.

If given a job to develop an improved instrument for measuring altitude for pilots, the research engineer probably would first examine presently used altimeters and study previous research attempts at developing such instruments. He wants to know what is wrong with present altimeters and what has been done to improve them. Likewise, the research psychologist would examine currently used evaluation procedures and study previous research in this area. In this project, we examined the evaluation procedures used by the Civil Aeronautics Administration, the military services, and the scheduled air lines. We also examined previous research in the measurement of flying proficiency. Our findings can be summarized as follows:

1. With almost no exception, currently used evaluation procedures are of one basic type. This type is a method by which a pilot makes an overall judgment of the performance of another pilot on a flight composed of various maneuvers. Typically, the observer rates the pilot on a scale made up of from two to five points representing various degrees of proficiency, such as:

> Excellent, Good, Fair, Poor, Failing
> Qualified or Unqualified
> 5, 4, 3, 2, 1
> Satisfactory or Unsatisfactory

2. The observer sometimes rates the pilot on each maneuver and averages these ratings for an overall rating, or he may make an overall rating that is independent of the maneuver ratings, or he may even give only an overall rating and not rate the individual maneuvers.

3. During the flight, the observer rarely makes any records of his own observations or of the performance of the pilot.

4. Previous investigators have repeatedly demonstrated that such evaluation procedures have low reliability. Using such procedures, two pilots rarely agree with each other as to the rating a particular pilot should receive. Reliability coefficients expressing the correlation between ratings made independently by two groups of observers on the same group of pilots have been consistently low—ranging from 0.11 to 0.35. In addition, such ratings have been found not to predict later success any better than a series of aptitude tests given before the pilots had received any training.

5. Previous research in this area suggested to us the feasibility of developing procedures incorporating the following principles: (a) evaluation should be based on check pilots' observations of smaller units of performance than a total flight or of units even smaller than a single maneuver; (b) these observations should be objective—that is, the observer should make use of such things as the readings of instruments, the position of the wings in relation to the horizon, the path of the airplane in relation to a radio range leg, etc.; (c) these observations should be recorded simultaneously with, or immediately after, the performance of the pilot; and (d) separate units of performance should be assigned scores, which, when added up with various weights, should comprise the total score for the entire performance.

Let us return now to the research engineer's problem. After examining currently used instruments measuring altitude and after studying previous research, the research engineer might then want to study the job of the pilot or to interview pilots in order to answer such questions as:

Presented at the Human Engineering in Aviation Session, Seventeenth Annual Meeting, I.A.S., New York, January 24–27, 1949.

* Formerly with the American Institute for Research.

1. Under what conditions does the instrument have to be read?

2. With what exactness does the pilot have to know his altitude—within 1 foot, 10 ft., 100 ft., or 1,000 ft.?

3. Within what range of altitudes does the pilot have to determine his altitude?

In short, the engineer would want to know the critical requirements of the pilot's job with respect to altitude determination.

Similarly, the psychologist needs to find out the critical requirements of the pilot's job with respect to success on the job. He asks himself, "What are the skills and techniques that are most critical from the standpoint of differentiating successful and unsuccessful job functioning?" In this project we attempted to answer this question by obtaining information from several sources:

1. First, we examined all of the pilot error accidents occurring in the scheduled domestic air lines for the past eight years. We extracted from these a list of critical pilot acts, each of which had contributed to an accident.

2. Secondly, we added to this list considerably by extracting similar critical behavior from reports of over 500 near-accidents collected by our interviewers from approximately 300 air-line pilots and Civil Aeronautics Administration examiners in over 20 cities throughout the country.

3. We analyzed approximately 1,200 unfavorable comments recorded on the grade slips and flight-check forms of 288 pilots eliminated from air-line pilot training.

These data consequently defined the most critical components of the pilot's job. We found 21 critical job requirements, which we ranked on the basis of the frequency with which they had contributed to unsafe situations. Our job then was to devise ways of measuring these requirements.

The engineer uses specialized skills and acquired experience in designing and constructing his experimental altimeter. Likewise, the psychologist relies upon certain specialized skills in the actual construction of his evaluation procedures. I shall not attempt to describe how a test is constructed but rather only point up some broad general procedural similarities between the engineer's task and the psychologist's in actually building the instruments. There are papers describing some of the work being done by psychologists in equipment design or human engineering. This type of research has convinced us all of the necessity of designing an instrument so that it can be used most effectively.

We were faced with a problem of a similar nature. In the past, check pilots have resisted evaluation procedures that required them to write down numerous observations during a check ride—and justifiably so. For the check pilot is at the same time both an evaluator and a safety pilot, being required to watch out for other airplanes and to keep a close tab on what the examinee is doing with the airplane. Our task was to develop some method of getting the check pilot to make an

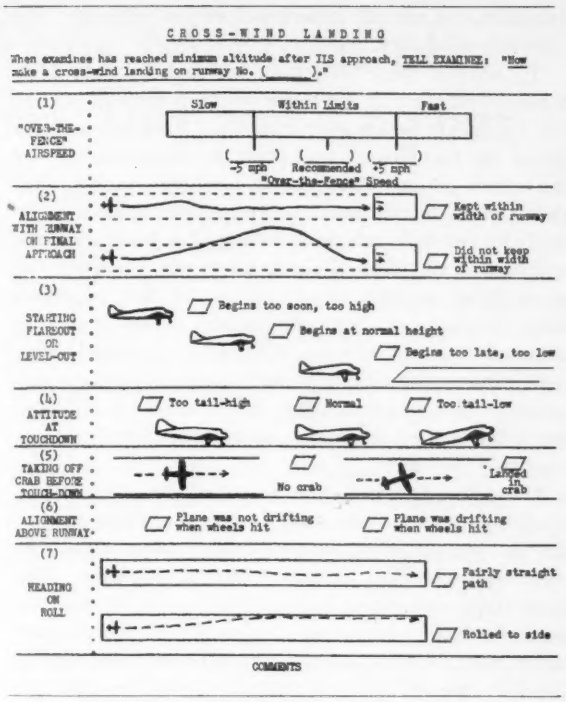

FIG. 1.

average of six observations on each of 12–15 maneuvers and to record these observations, yet without requiring much of his time for this. Perhaps, if I describe the procedure that we developed for just one maneuver, it will illustrate how we tried to lick this problem.

One of the maneuvers in our procedure is a cross-wind landing. While the examinee performs this maneuver, the check pilot must score him on seven items. The check pilot has a form that lists these seven items (Fig. 1).

The illustrations used liberally in our flight-check form are visual aids for the check pilot, making it much easier for him to locate an item and to record the performance of the examinee on that item. Tests have shown that the check pilot can score an entire maneuver in less than a minute. The use of these pictorial representations has helped to make the flight-check form more acceptable to those who will use it.

Let us return to the next problem facing the engineer after he has developed his new altimeter. The research engineer undoubtedly will want to determine whether his instrument is reliable. Does it give the same measure of altitude under different conditions of application, or will it give a different altitude each time it is used? The psychologist who designs an instrument of evaluation must also determine the reliability of his test. In this project we wanted to know the answers to two questions: (1) To what extent will the scores on this test be alike when the test is administered to the same pilot on the same flight by two independent observers? (2) To what extent will the scores on this test be alike when two different observers give the test, one on one day and the other on the next day? These de-

terminations we call observer-observer reliability and ride-ride reliability.

To answer these questions, we first conducted an experiment using 27 Air Force pilots as subjects and 30 Air Force instructors as check pilots. Each subject was given the flight check and observed independently by two check pilots. Then, on the next day, each subject flew the check ride again and was observed independently by two different check pilots. By comparing the scores of all the pairs of check pilots who observed the same flight, we obtained a measure of the "observer-observer reliability" of the flight check. The correlation between the observers was 0.88, which is considerably higher than reliabilities of currently-used evaluation procedures. They indicate that in the hands of different check pilots the instrument yields scores which are exceedingly similar.

Then, by comparing the scores of the check pilots observing the first flight with the scores of those observing the second flight, we obtained a measure of the "ride-ride reliability" of the evaluation procedure. The correlation coefficients between the scores on the two rides was 0.60. Again, this correlation is considerably higher than the reliabilities of currently-used procedures. The ride-ride reliability is naturally lower than the observer-observer reliability because of the inevitable variation in the performance of the pilot. But it does indicate that this type of test measures abilities of the pilot which are relatively consistent from day to day.

The final job of the engineer is to convince himself that his instrument is actually measuring altitude and not some other variable. To prove the instrument's "validity," the engineer checks his instrument against some external or independent criterion of altitude. Similarly, the psychologist must check his evaluation procedure against some external criterion of pilot proficiency. Ordinarily, this is a more difficult job for the psychologist than for the engineer. In this project, for example, we have only a limited number of such criteria. The dilemma here is that the new test procedures are more reliable than most of the external criteria of pilot proficiency. We could test a large group of pilots, wait ten years, and then examine their accident records to see whether those originally rated highest had the fewest accidents; but air-line accidents are not that frequent and they are not always caused by lack of pilot proficiency.

Actually, in this project, we used the judgments of a large number of experts with respect to whether they felt that the test required the examinee to perform the kinds of tasks that he is called upon to perform on the job. We also relied heavily upon the fact that the test was constructed to a great extent upon the list of pilot behaviors that had been shown to have been critical. It is planned later to validate these procedures against the criterion of success or failure in training.

In conclusion, may I express the hope that this brief presentation of a psychological problem as a parallel to an engineering problem has resulted in some communication between the different professional groups conducting research in the broad field of aviation.

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Comparison of Various Methods of Thrust Augmentation for Turbojet Engines

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SUMMARY

A theoretical comparison has been made of various methods of thrust augmentation for turbojet engines. The methods investigated were tailpipe burning, water injection at the compressor inlet, a combination of tailpipe burning plus water injection, bleed-off in conjunction with water injection at the compressor inlet, and rocket assist.

The results indicate that either bleed-off or rocket assist offers the possibility of large thrust increases at the expense of high values of specific liquid consumption. For small increases in thrust, water injection offers the advantage of simplicity and light weight. Tailpipe burning offers the advantage of light weight with thrust increases intermediate between those for water injection and bleed-off and the advantage of the lowest values of specific liquid consumption. Tailpipe burning may, however, involve some loss of thrust during unaugmented operation. The combination of tailpipe burning plus water injection permits a flexible system, providing either large amounts of augmentation with a moderate specific liquid consumption or smaller amounts with a low specific liquid consumption.

Increasing the flight Mach Number greatly increases the thrust augmentation produced for all of the methods considered whereas increasing the altitude of operation decreases somewhat the amount of augmentation produced. For continued operation at a flight Mach Number of 1.5, tailpipe burning appears to be the only augmentation method of those considered which increases the maximum range of an airplane over that obtained with the normal engine.

INTRODUCTION

IN THE PRESENT PAPER, various methods of thrust augmentation are compared over a range of flight conditions and amounts of augmentation to determine the relative efficiency, additional weight, and applicability of each method. The methods considered are tailpipe burning, water injection at the compressor inlet, a combination of tailpipe burning plus water injection, and bleed-off with water injection. The method of tailpipe burning plus water injection, although not previously discussed, is also considered to be of interest and is included to show what might be expected of it. Because rocket-assist units have been used to a large extent in assisting the take-off of conventional aircraft, their performance is compared with that of the other methods.

THRUST-AUGMENTATION ANALYSIS

The comparison of augmentation methods was made for altitudes of sea level and 35,000 ft. and for flight Mach Numbers of 0, 0.85, 1.50, and 2.50. The thrust augmentation of the engine was found from step-by-step calculations of the performance of both the normal and the augmented engine. The efficiencies chosen were polytropic and are, for the compressor, 0.80; for the turbine, 0.85; for the exhaust nozzle, 0.95; and for the inlet diffuser, 1.00, 0.85, 0.80, and 0.70 for flight Mach Numbers of 0, 0.85, 1.50, and 2.50, respectively. The primary combustion-chamber total-pressure loss was assumed to be 3 per cent of the combustion-chamber-inlet total pressure. The drag coefficient of the tailpipe burner (ratio of total-pressure loss to inlet velocity head) was assumed to be 0.5. Two fixed engines, one having a constant compressor work input of 85 B.t.u. per lb. of air and the other having twice the work input or 170 B.t.u. per lb. of air, were assumed to operate over the entire range of altitudes and flight speeds. These values of work input give compressor pressure ratios at sea-level static conditions of about 4 and 11 and correspond to one- and two-stage centrifugal compressors, respectively. The exhaust-nozzle area was assumed to be adjusted for all cases to give tailpipe temperatures of 1,650°R. for the engine with the low-pressure-ratio compressor and 1,500°R. for the engine with the high-pressure-ratio compressor. These values give turbine-inlet temperatures of about 1,960° and 2,100°R., respectively.

With tailpipe burning, the tailpipe area was assumed to be double the normal tailpipe area in order to establish a reasonable burner-inlet velocity, and charts which account for the effects of dissociation were used to calculate the temperature for various tailpipe fuel-air ratios. Calculations were made for fuel-air ratios up to stoichiometric.

For the water-injection calculations, the compressor efficiency was decreased 1 per cent for each per cent of water added at the compressor inlet. For each flight condition, calculations were made with varying amounts of water injected at the compressor inlet to the point where the compressor-outlet air was saturated.

With bleed-off, the amount of augmentation for a given liquid injection increases rapidly with an increase in the amount of air bled off. Bleeding off large quantities, however, increases the mass flow of air through the compressor and the pressure ratio across the turbine and may result in large decreases in the efficiencies of these components. For this comparison, it was assumed that the area of the primary-engine exhaust nozzle was the same as for normal engine operation at sea-level static conditions and that the efficiency and pressure ratio of the compressor and the efficiency of

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* Head, Propulsion Systems Analysis Section.

the turbine were not altered by bleed-off. Higher values of augmentation may be obtained on some engines if the exhaust-nozzle area is permitted to vary. For each flight condition, bleed-off was considered for the case where just sufficient water was injected at the compressor inlet to saturate the air at the compressor outlet. In all cases, the turbine-outlet temperature was maintained at the assumed value by adjusting the amount of air bled off for each amount of water injected into the combustion chamber. The ratios of water flow injected in the primary combustion chamber to bleed-off flow were calculated theoretically. The bleed-off or auxiliary burner was assumed to operate with a stoichiometric fuel-air ratio in all cases.

The rockets were assumed to have a specific impulse of 190 lbs.-sec. per lb. for all conditions of altitude and flight speed.

Based upon these assumptions, the values of augmentation presented are somewhat higher than the values generally obtained experimentally from the various methods. The degree of optimism is about the same, however, and the results are believed to rate the systems in the correct order on the basis of performance.

Results and Discussion

Thrust Augmentation

A comparison of the various thrust-augmentation methods for sea-level static conditions, based on the aforementioned assumptions and methods of analysis, is shown in Fig. 1. The ratio of augmented thrust to normal thrust is plotted against the ratio of the total liquid consumption of the augmented engine to the fuel consumption of the normal engine. These results are for the engine with the low-pressure-ratio compressor. Because the engine was assumed to operate at a constant rotor speed, the compressor pressure ratio changes with change in flight conditions and with the injection of water. The range of pressure ratios obtained with this compressor is from 4.3 to 5.0 at sea-level static conditions. The pressure ratio 4.3 is obtained with the normal engine, and the pressure ratio 5.0 is obtained with water injection.

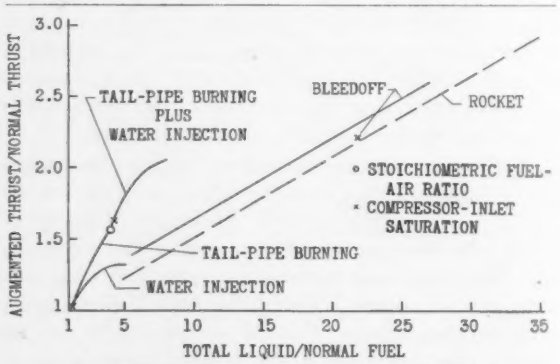

Fig. 1. Variation of ratio of augmented to normal thrust with ratio of total liquid to normal fuel.

With water injection, a thrust ratio of 1.33 can be obtained at a liquid ratio of 5.0 when injecting sufficient water to saturate the air at the compressor outlet. The condition for which just sufficient water is injected to saturate the air at the compressor inlet is represented by the lowest cross (Fig. 1). The most economical method is tailpipe burning, which can provide a maximum thrust ratio of 1.55 at a liquid ratio of 4.0 as compared to 1.32 with water injection at this liquid ratio. The circle on the tailpipe burning curve (Fig. 1) represents a stoichiometric fuel-air ratio and is the maximum that can be obtained with tailpipe burning. Although it is not readily discernible in the figure, a thrust loss of about 2 per cent relative to the normal engine is obtained with the tailpipe burning configuration during unaugmented operation because of the greater pressure losses in the tailpipe. Large increases in thrust can be obtained by adding water injection to the tailpipe burning method when the overall fuel-air ratio is stoichiometric. A thrust ratio of 2.05 at a liquid ratio of 8.0 can be obtained by this method when saturating the air at the compressor outlet. The cross on the curve for tailpipe burning plus water injection (Fig. 1) represents the condition for which just sufficient water is injected to saturate the air at the compressor inlet.

Bleed-off is less efficient than tailpipe burning or the combination of tailpipe burning plus water injection, inasmuch as a higher liquid ratio is required for the same thrust ratio. A higher maximum thrust ratio is possible, however, with bleed-off. For example, a thrust ratio of 2.60 can be obtained with bleed-off as compared to a maximum of 2.05 for the combination of tailpipe burning plus water injection. Further increases in the thrust ratio with bleed-off are not possible because stoichiometric fuel-air ratio is reached in the primary combustion chamber. If the amount of water injected at the compressor inlet is limited to that amount required to saturate the air at the compressor inlet instead of the outlet, the maximum thrust ratio of 2.20 is obtained as represented by the cross below the curve for bleed-off (Fig. 1).

The rocket-assist method is the least efficient inasmuch as it requires the highest liquid ratio for a given thrust ratio. It is, however, approximately competitive with the bleed-off method and, furthermore, has no theoretical limit on maximum thrust ratio. For a thrust ratio of 2.05, which can be obtained by the combination of tailpipe burning plus water injection, the bleed-off and rocket-assist methods require from 2 to 2.5 times the liquid ratio.

The results for the same conditions as Fig. 1, except at a flight Mach Number of 0.85, are shown in Fig. 2. The compressor pressure ratio was reduced to 3.7 at a flight Mach Number of 0.85 as compared to 4.3 at a flight Mach Number of zero because of the higher air temperature at the compressor inlet. The curves obtained are similar to those for a flight Mach Number of zero except that greater values of the thrust ratio are obtained for the same values of the liquid ratio. For example, at a liquid ratio of 8.0, a thrust ratio of 2.90

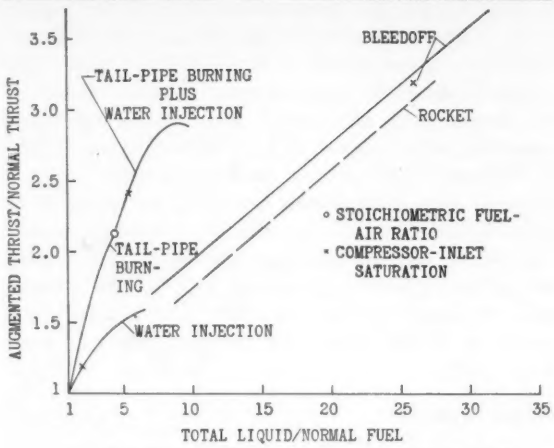

FIG. 2. Variation of ratio of augmented to normal thrust with ratio of total liquid to normal fuel.

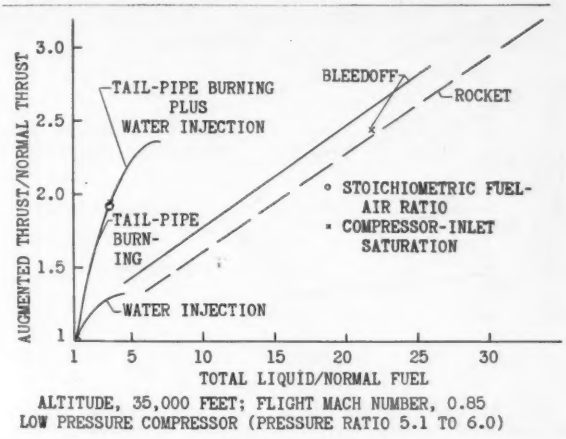

FIG. 3. Variation of ratio of augmented to normal thrust with ratio of total liquid to normal fuel.

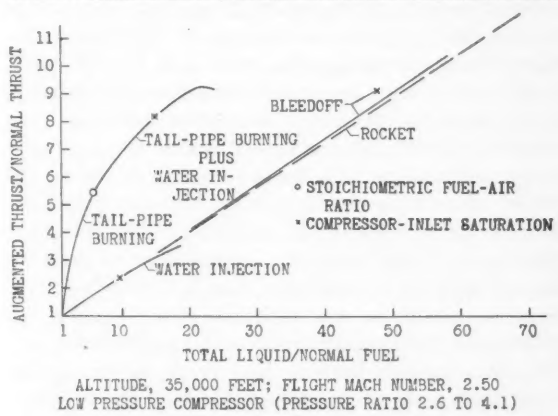

FIG. 4. Variation of ratio of augmented to normal thrust with ratio of total liquid to normal fuel.

can be obtained with the combination of tailpipe burning plus water injection as compared to 2.05 at a flight Mach Number of zero. Water injection with saturation at the compressor inlet is more effective for the higher flight Mach Number because of the higher compressor-inlet temperature. A maximum thrust ratio of 3.70 at a liquid ratio of 31.5 can be obtained with bleed-off.

In order to show the comparison of the various methods at high altitudes, Fig. 3 is presented for an altitude of 35,000 ft. The flight Mach Number for this case is 0.85. The trends are similar to those for sea level. Both the maximum thrust ratio and the thrust ratio for a given liquid ratio are, however, less for each method. A maximum thrust ratio of 1.32 can be obtained with water injection at a liquid ratio of 4.5. Water injection with only sufficient water to saturate the air at the compressor inlet is much less effective at the higher altitudes because of the lower inlet-air temperature. With tailpipe burning, the maximum thrust ratio is 1.92 at a liquid ratio of 3.5. Adding water injection to tailpipe burning increases the maximum thrust ratio to 2.36 at a liquid ratio of 7.0. Bleed-off can provide a maximum thrust ratio of 2.88 at a liquid ratio of 26.0.

The results for a flight Mach Number of 2.5 at 35,000 ft. are given in Fig. 4. With an increase in flight Mach Number from 0.85 to 2.50, the maximum thrust augmentation obtained from each method is increased about five times. The effectiveness of water injection is more rapidly increased than the effectiveness of the other methods by an increase in flight Mach Number. Saturating the air at the compressor inlet gives a thrust ratio of 2.4 with water injection at a liquid ratio of 9.6. The maximum thrust ratio obtained with water injection is 3.5 at a liquid ratio of 18.6. With tailpipe burning, the maximum thrust ratio is 5.5 at a liquid ratio of 6.0. Adding water injection to tailpipe burning until the compressor inlet air is saturated results in a thrust ratio of 8.2 at a liquid ratio of 15.0, and increasing the water-injection rate results in a maximum thrust ratio of 9.3 at a liquid ratio of 22. The maximum thrust ratio with bleed-off is 10.4 at a liquid ratio of 58. The high liquid ratios for the methods involving the injection of water are due to the large quantities of water that can be evaporated at the high Mach Numbers because of the high inlet-air temperature.

The effect of altitude on the maximum thrust ratio is more clearly shown in Fig. 5. The maximum thrust ratio of each method is plotted against altitude for a flight Mach Number of 0.85. All methods show a moderate decrease in maximum thrust ratio as the altitude is increased to 35,000 ft. Because of the constant air temperature above the tropopause (approximately 35,000 ft.), the augmentation remains about constant. The maximum thrust ratio with water injection decreases from 1.59 to 1.32 as the altitude is increased from sea level to 35,000 ft. Tailpipe burning is affected to a smaller extent by altitude than any of the other methods; the maximum thrust ratio decreases from 2.12 to 1.92. The combination tailpipe burning plus water injection decreases from 2.90 to 2.36, and bleed-off decreases from 3.70 to 2.88 as the altitude increases from sea level to 35,000 ft.

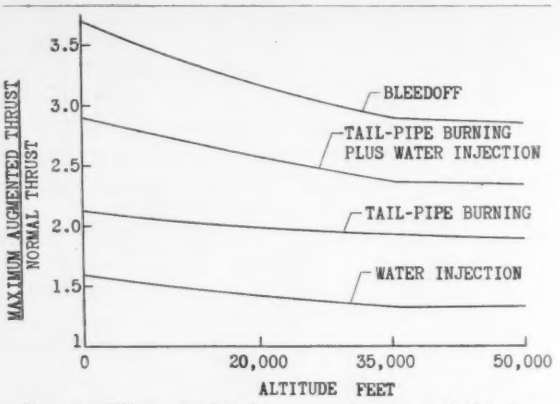

FIG. 5. Effect of altitude on maximum available thrust augmentation. Flight Mach Number, 0.85; low-pressure-ratio compressor (pressure ratio, 3.9 to 6.0).

In order to show the effect of flight Mach Number on the augmentation more clearly, the maximum thrust ratio of each method is plotted against flight Mach Number in Fig. 6 for an altitude of 35,000 ft. The flight Mach Number ranges from 0.85 to 2.50. All methods show an increase in the maximum thrust ratio as the flight Mach Number is increased although, as shown previously, the increased thrust ratios are obtained at the expense of large increases in the liquid ratios. Increasing the flight Mach Number from 0.85 to 2.50 increases the thrust ratio with bleed-off from 2.88 to 10.4, and, with the combination of tailpipe burning plus water injection, from 2.34 to 9.3. At a flight Mach Number of 2.50, however, the liquid ratio with bleed-off is about ten times that for tailpipe burning, and, with tailpipe burning plus water injection, the liquid ratio is about four times that for tailpipe burning.

The preceding results are all for an engine having the low-pressure-ratio compressor. The performance of the high-pressure-ratio compressor engine is presented in Fig. 7 together with the performance of the low-pressure-ratio-compressor engine for comparison. The thrust ratio is plotted against the liquid ratio for sea level and a flight Mach Number of 0.85. For these flight conditions, the high-pressure-ratio compressor has a normal pressure ratio of 9.9 which is increased to 14.3 with water injection. In the range of liquid ratios

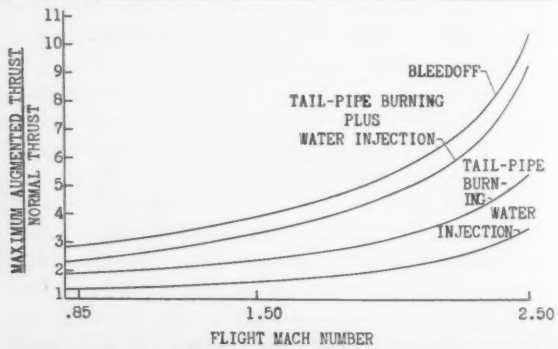

FIG. 6. Effect of flight Mach Number on maximum available thrust augmentation. Altitude, 35,000 ft.; low-pressure-ratio compressor (pressure ratio, 2.6 to 6.0).

covered by the low-pressure-ratio-compressor engine, there is little difference between values of the thrust ratio for a given liquid ratio for the low- and high-pressure-ratio-compressor engines. Higher values of the thrust ratios are possible with the high-pressure-ratio-compressor engine but at higher values of the liquid ratio. The greatest increase in thrust ratio is obtained with the methods involving water injection. For example, the maximum thrust ratio with the combination of tailpipe burning plus water injection increases from 2.90 to 4.36 whereas with tailpipe burning alone the maximum increases from 2.12 to 2.26. The maximum thrust ratio with bleed-off increases from 3.70 to 4.98.

Weight Analysis

In addition to the weight of the liquid consumed by each method, the weight of the added equipment required by each method is also of importance. Fig. 8 shows a comparison of the weight required for the various methods for take-off. The sum of the engine weight, the equipment weight, and the fuel or liquid weight required for 6 sec. of operation, divided by the normal engine weight is plotted against the thrust ratio. The fuel and liquid requirement for 6 sec. of operation is included to account for the added weight that must be carried during the climb part of the take-off operation. It is assumed that any additional fuel and liquid required for the ground run can be carried by increasing the gross weight during this part of the take-off operation. The gross weights will, therefore, be the same at the end of the ground run. The comparison, therefore, is on the basis of the weight of the augmentation equipment plus the fuel and liquid for 6 sec. of climb. For a rate of climb of 500 ft. per min., 6 sec. corresponds to a climb of 50 ft. In all cases, the additional weight due to fuel is less than one third of the total additional weight, and, therefore, changes in the time to climb would not appreciably affect the comparison. The weights of the additional equipment were estimated from the weights of experimental equipment by taking into account any modifications required for airplane installation. The specific weight of the rocket-assist equipment less propellants—that is, the ratio of weight to thrust—was assumed to be constant for all values of thrust augmentation and times of operation; a value of 0.075 was assumed. Although the specific weight of rocket motors varies considerably for different units, the value of 0.075 is an average value for several light-weight solid- and liquid-type rocket motors operating for various periods of time up to 4 min.

These curves show that for small amounts of augmentation, below about 20 per cent, the rocket method entails the least additional weight. For values of augmentation above 20 per cent, the augmentation methods in order of increasing weight of additional equipment are: water injection, tailpipe burning, combination of tailpipe burning plus water injection, bleed-off, and rocket assist. The best augmentation method for take-off depends on the maximum value of

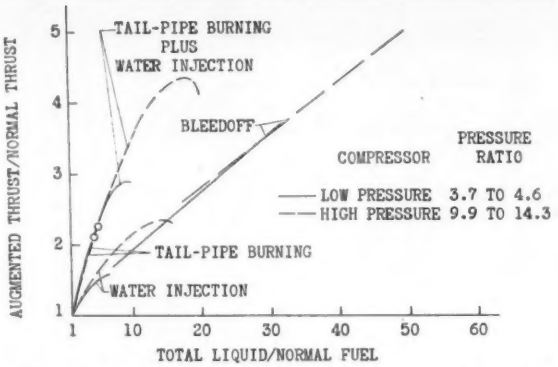

FIG. 7. Effect of compressor pressure ratio on thrust augmentation and ratio of total liquid to normal fuel. Altitude, sea level; flight Mach Number, 0.85.

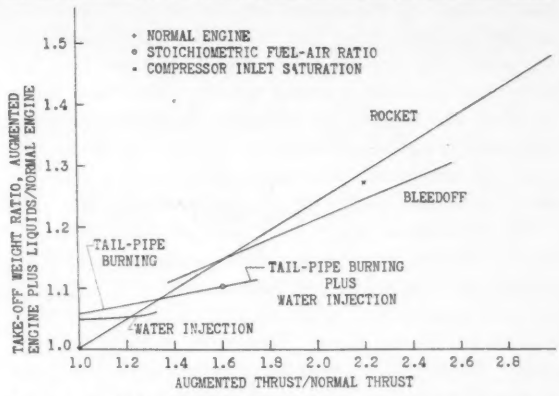

FIG. 8. Variation of take-off weight with ratio of augmented to normal thrust.

augmentation required. For example, if the augmentation required for take-off is 70 per cent, the best method from an additional-weight standpoint is the combination of tailpipe burning plus water injection. For this method and value of augmentation, the weight of the engine, equipment, and liquids for 6 sec. of operation is 11 per cent greater than the weight of the normal engine.

Load-Range Characteristics

Because of the high thrusts for a given engine size and weight, engines equipped with these thrust-augmentation systems may be desirable for high-speed flight in spite of their high liquid consumption. A study was therefore made of the performance of the complete airplane for a flight Mach Number of 1.50 at which the engine was assumed to be operating in the augmented configuration for the entire time of flight. The details of this study and method of analysis are similar to those in Reference 1, in which various engine types are compared in terms of airplane load-range characteristics.

In Fig. 9, the airplane disposable load per lb. of gross weight is plotted against the liquid rate per mile per ton of gross weight. This comparison is for an altitude of 35,000 ft. and a flight Mach Number of 1.50. The performance is calculated for level flight only and does not include the take-off and climb requirements. The disposable load is equal to the gross weight less the weight of the airplane structure and the engine and may consist of liquid weight or liquid and cargo weight. A wing lift-drag ratio of 7 was assumed, and the airplane structure weight was assumed to be 30 per cent of the gross weight. The normal engine specific weight at sea-level static conditions was assumed to be 0.45, and the weight of the additional equipment was taken to be the same as that used in the comparison in Fig. 8. The engines were assumed to be installed in nacelles. The nacelle and fuselage drag and the drag of the additional equipment were deducted from the engine thrust in calculating the gross weight from the lift-drag ratio. All calculations are based on an airplane gross weight of 150,000 lbs. The normal engine was assumed to have a thrust per unit frontal area of 800 lbs. per sq.ft. at sea-level static conditions.

Operation with the normal engine is shown (Fig. 9) by the plus in the lower left corner. The various lines represent the different methods with varying amounts of augmentation. The ratio of ordinate to abscissa and, therefore, the slope of the slanting lines connecting the points on the curves with the origin represent the maximum range of the airplane when all of the disposable load is fuel. These slopes have been labeled directly in terms of range on the outer scale. With the normal engine, for example, the airplane has a maximum range of 415 miles. The initial point for tailpipe burning at a thrust ratio of about 1 is at a lower disposable load and range than the normal engine because of the loss in thrust and the increase in drag when the engine is equipped for tailpipe burning. As the augmentation by tailpipe burning is increased to stoichiometric, the ratio of disposable load to gross weight and the range are increased without much increase in liquid rate per mile per unit gross weight. The liquid rate per ton-mile remains nearly constant with augmentation by tailpipe burning in spite of the increase in specific fuel consumption for the following reason: One of the important factors that affects this quantity is the liquid rate per hour per lb. of net thrust, where the net thrust is defined as the difference between the engine thrust and the engine

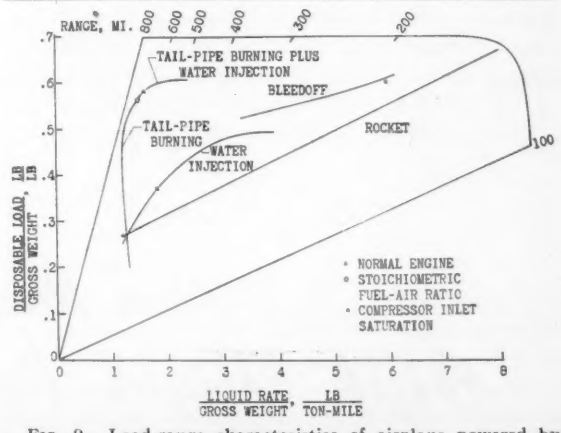

FIG. 9. Load-range characteristics of airplane powered by turbojet engines with various methods of thrust augmentation. Altitude, 35,000 ft.; flight Mach Number, 1.50.

nacelle drag. By augmentation, the engine thrust is increased without an increase in nacelle drag, and, hence, the percentage increase in net thrust is greater than the percentage increase in engine thrust. This effect tends to offset the increase in fuel rate per pound of engine thrust to give an approximately constant liquid rate per pound of net thrust (and hence gross weight) with increase in augmentation by tailpipe burning.

The maximum range with tailpipe burning is 750 miles. Adding water injection to tailpipe burning increases the disposable load but, because of the increase in liquid rate per unit gross weight, results in a slightly shorter maximum range than with tailpipe burning alone. Water injection alone results in about the same maximum range as the normal engine. The principal effect of bleed-off is to increase the disposable load per unit gross weight with an increase in liquid rate per mile per unit gross weight and some decrease in maximum range. The rocket-assist method provides the greatest increase in disposable load but with the highest liquid rate per unit gross weight, resulting in the lowest maximum range. From these curves, it may be concluded that for a flight Mach Number of 1.50, tailpipe burning is the only method, when used for the entire flight, that will increase the range over that for a normal engine.

These results are based on rather conservative estimates of engine performance. The computations for the tailpipe burning method and for the method of tailpipe burning plus water injection were repeated for a more efficient engine to determine whether the general conclusions apply for this case. The results of these computations are shown in Fig. 10. Included for comparison are the corresponding results from Fig. 9, which are designated engine A. For engine B, both the compressor and turbine efficiencies were increased 5 per cent and the inlet-diffuser efficiency was increased from 0.80 to 0.965. Somewhat higher values for the engine thrust per unit engine weight and frontal area were also assumed. The airplane gross weight for case B was equal to that for case A, namely, 150,000 lbs. The maximum range of the airplane with engine B without tailpipe burning is 1,035 miles. As the augmentation increases, the maximum range increases to 1,140 miles. Although this increase in range with the addition of tailpipe burning is not as great as with engine A, it appears safe to conclude that even with a highly efficient engine the addition of tailpipe burning will somewhat increase the maximum range and provide a considerable increase in disposable load per unit gross weight.

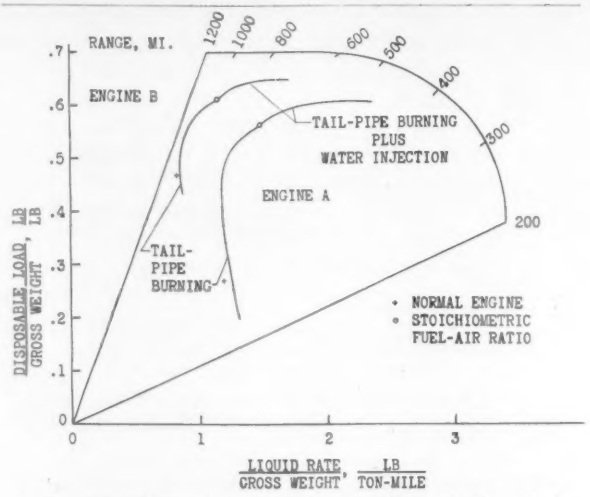

FIG. 10. Comparison of load-range characteristics of airplane with two different engines. Altitude, 35,000 ft.; flight Mach Number, 1.50.

SUMMARY OF RESULTS

From a theoretical comparison of various methods of thrust augmentation, it may be stated that either bleed-off or rocket assist offers the possibility of large thrust increases at the expense of high values of specific liquid consumption. For small increases in thrust, water injection offers the advantage of simplicity and light weight. Tailpipe burning offers the advantages of light weight with thrust increases intermediate between those for water injection and bleed-off and of the lowest values of specific liquid consumption. Tailpipe burning may, however, involve some loss of thrust during unaugmented operation. The combination of tailpipe burning plus water injection permits a flexible system, providing either large amounts of augmentation with a moderate specific liquid consumption or smaller amounts with a low specific liquid consumption. For continued operation at a flight Mach Number of 1.5, tailpipe burning appears to be the only augmentation method of those considered that increases the maximum range over that obtained with the normal engine.

REFERENCE

[1] Cleveland Laboratory Staff, *Performance and Ranges of Application of Various Types of Aircraft-Propulsion Systems*, U.S., N.A.C.A. TN No. 1349, 1947.

Plan Now to Attend

Fifth Flight Propulsion Meeting

Hotel Carter, Cleveland, March 24

Some Operational Aspects of Distance-Measuring Equipment in the Transition Air Navigation System

J. WESLEY LEAS*

Air Navigation Development Board

Introduction

When approach control requests "What is your present position?" and you reply, "Eleven and four-tenths miles on a bearing of 94° from the field," the Transition Air Navigation System will be truly here. This is the name given to the common military, civil, and private system of air navigation and traffic control being developed by the Air Navigation Development Board. It is expected to be implemented fully by the first of 1954. The replacement for the Transition Period Common System, the so-called Ultimate System, is expected to be in operational use by 1964. Its development is just being started by the Air Navigation Development Board. In order to have made that report to approach control, you would have had at least the VHF navigation receiver and the distance-measuring equipment aboard your aircraft. You are already familiar with what the VHF omnidirectional range, VOR, will give you in the way of navigation assistance. It is also part of the transition air navigation system. Now I would like to discuss with you just what you will get from the distance-measuring equipment and what some of its operational problems are.

The name certainly is self-explanatory, but perhaps the method by which it operates is not so clear. I'm sure that many of you are familiar with the use of responder beacons with air-borne radar. The distance-measuring equipment is a similar device in that it sends out a pulse train from the air-borne equipment, known as the interrogator, which interrogates a receiver on the ground, which, in turn, triggers a transmitter associated with it; the receiver-transmitter unit is called a transponder. The reply, when received by the interrogator, gives a measure of time which can be converted into distance and presented visually to the pilot. The DME can automatically search to locate the station's distance since this is not known when a new channel is selected. Once the station distance has been found, the distance is tracked automatically as it increases or decreases. There is available continuous indication of distance from particular points on the ground, such as VOR and ILS stations; when DME is used with a VHF navigation receiver and Computer, continuous distance from particular selected way points is also available. No longer will you have to wait for intersections of range legs, cones of silence, or fan markers to know your position exactly. It will be available at a glance on the instrument panel.

You are undoubtedly wondering when you will see such equipment. The DME has been under development in this country since the middle of 1945. The International Civil Aviation Organization recently agreed to a development specification for DME which, it is hoped, will lead to an international standard. The Air Navigation Development Board has just written the system characteristics that will serve as the standard for the common military and civil DME system. The C.A.A. and Air Force are planning on letting production contracts during the fiscal year 1950, with the Navy following shortly, and the commercial air lines are in the process of preparing their specification for the air-borne equipment. You should see it in operation in approximately three to four years. To give you a preview, Figs. 2–6 show some of the equipment.

I am sure that you are wondering about its physical and financial characteristics. Our best estimates to date indicate that it will occupy about one ATR rack, and that its weight installed will be about 50 pounds. The best estimate on cost is somewhere around $2,000–$3,500.

Operational Aspects

Presentation

While I mentioned that the distance indication will be given continuously, the form of presentation is one on which there is considerable discussion at the present time. For instance, should the indication be similar to the barometric altimeter or should it be perhaps by Veeder counters? Or, alternately, should the indication be similar to the radio altimeter using a straight meter

Presented at the Annual Summer Meeting, I.A.S., July 21–22, 1949.

* Member, Technical Staff.

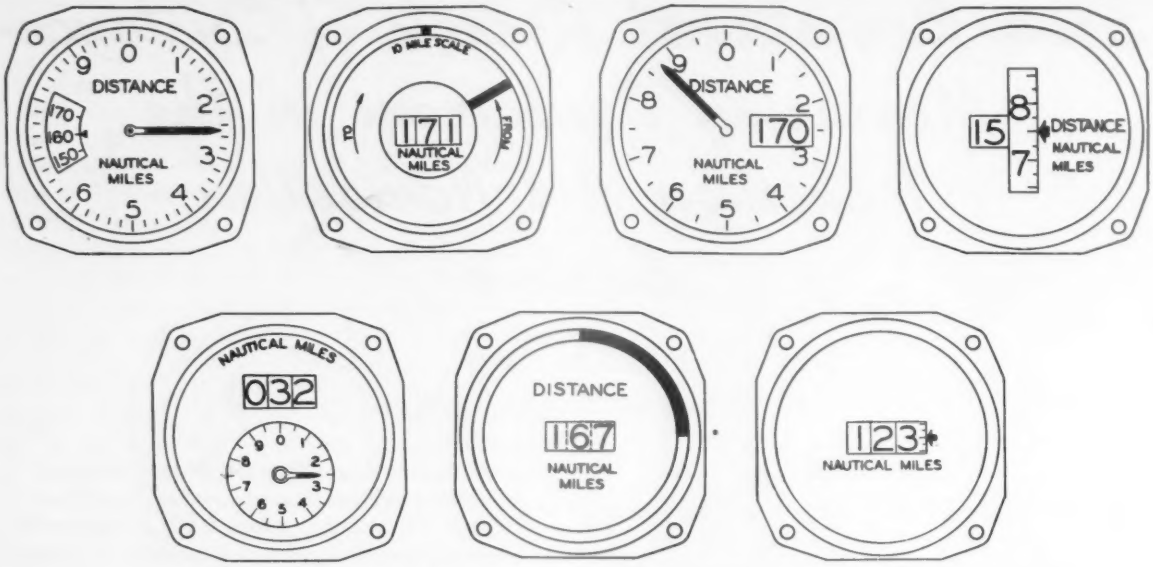

FIG. 1. DME indicators under evaluation.

presentation? Or, perhaps, you would like a combination meter and Veeder counter presentation. A special committee of the Radio Technical Commission for Aeronautics is studying this problem and has under consideration the indicators shown in Fig. 1.

This special committee has made certain recommendations although its work is not yet complete. Among them are the following: The indicator must show continuously a relative rate of closure; numerals on the indicator must be not less than $^1/_2$ in. high with a minimum indication of 0.2 mile and a maximum of 200 miles; the indicator must be a standard $3^1/_8$-in. diameter meter with a maximum depth, including connectors, not to exceed 8 in.; furthermore, there should be no "doghouse" on the front of the meter face; and there shall be a flag-alarm-type indicator that will serve to warn the pilot if the reading on the meter is to be disregarded. The committee has also determined that the DME should furnish a shaft rotation such that the distance indication can be remoted accurately to several positions.

Coverage

After acquainting you with the various types of indication that are being considered, I should now like to discuss with you the distance requirements of the equipment.

First of all, let us take the case where the DME is used with a VOR. As you undoubtedly know, the VOR's are usually situated approximately 90 miles apart. Consequently, we want the DME to have a coverage of at least half this distance in order that we may fly from one VOR-DME station to the next and get continuous indication of distance. Then, as you consider high-flying aircraft that perhaps only tune in to every other VOR-DME along an airway, the coverage must be equal to the spacing between the VOR's. When you go further and say that you may want distance-measuring equipment in jets, which begin their descent some 200 miles from destination, you would perhaps like even to double the coverage of the DME again. This brings the distance requirement up to around 200 miles.

The low-altitude distance requirement is set by the minimum instrument altitude. This is 1,000 ft. above terrain. The DME will give coverage to 45 miles at 1,000 ft. and so should maintain continuous signal between VOR-DME stations at minimum instrument altitude.

As DME will also be installed along with the Instrument Landing System and GCA, let us consider what these distance requirements are. The present international standards for the localizer require that it give coverage out to 25 miles, and the search portion of the GCA is 30 miles. The DME should give coverage at least equivalent to these. Much greater coverage is, of course, not difficult to obtain. However, since the length of time that it takes to lock on to the signal from a DME station is dependent on the distance over which the equipment must search, it is, perhaps, highly desirable to limit the search when the equipment is tuned to a DME associated with an ILS installation. It has been suggested that this limitation should be in the order of 40 miles. Then, should a signal be lost momentarily, the researching operation would take far less time than if the distance were actually 200 miles. It will require about 30 sec. to search 200 miles but probably less than 8 sec. to search 40 miles.

While the attainment of the operational coverage for final approach is quite easy, there has been considerable question about the zero point of this distance measurement. Should it be at the localizer end of the runway, should it be at the touchdown point, or should it, perhaps, be at the center of the airport? Based on experi-

ence with similar gear developed in Britain during the war, the consensus now seems to favor giving distance to touchdown. If it were given to the far end of the runway, you would have to subtract the runway length to determine the distance to touchdown. Although an installation at the center of the field might be more universal for approach, it would not adequately serve for distance to touchdown.

We have talked considerably about the coverage of the system far out, but what are the considerations in close? We have heard of the cone of silence or cone of confusion over the VOR. Does such a cone exist over the DME transponder? In our tests to date, we have not found any cone. Preliminary measurements indicate that there will not be any cone directly over the transponder up to at least 50,000 ft. Whether this is, in fact, a strong advantage is open to question and certainly, if a cone of silence should be desirable, it can be provided. Of course, you realize that when passing over a station, the distance indication does not go to zero but rather reads the altitude that you are above the station as you pass over it.

Accuracy

Once we have examined the presentation and the coverage of the system, your next question undoubtedly will be, "What is the accuracy?" Let us take the case where the DME is associated with the VOR. From the navigation standpoint, the VOR is perhaps limited to an accuracy of the order of ±2–3°. If that is the case, the DME inaccuracy can be as great as 3–5 per cent before it begins to affect materially the Rho-Theta system accuracy, for at 50 miles from the VOR on a 15-mile offset course, the VOR inaccuracy for 3° error is ±2.4 miles laterally. A 5 per cent DME system would add only ±0.75 mile to this error. A similar error would exist longitudinally along this course. Next, let us consider the application of DME directly feeding into a rate device that will give ground speed when flying radials toward or away from the DME station. For this use, the DME accuracy must be quite good. To give an accuracy of rate indication of, let us say, 10 m.p.h. will require a DME random error of less than 0.1 mile and a period of integration of 36 sec., or, if the random error can be less than 0.01 mile, the time to obtain the accuracy required would be 3.6 sec. With such a system, of course, not only ground speed can be made available, but, when this is compared with the actual distance, time to the station or an ETA indication can be given. In this instance, a longer integration time may be tolerated, and hence the random error need not be as low as needed for ground speed.

Now, let us look at the problem from the standpoint of traffic control. What accuracy is desired in the DME? When the VOR, DME, and Computer are used, traffic control will be interested in knowing that the aircraft has sufficient accuracy to maintain lateral separation from other aircraft at the same altitude. As in the navigation example, the DME does not become the limiting factor until its inaccuracy is somewhat greater than 5 per cent. From the standpoint of longitudinal separation with the 10-min. spacing that is now standard along the airways, high accuracy of DME indication is not needed, but, with only 5 per cent accuracy, this time separation may be cut in half.

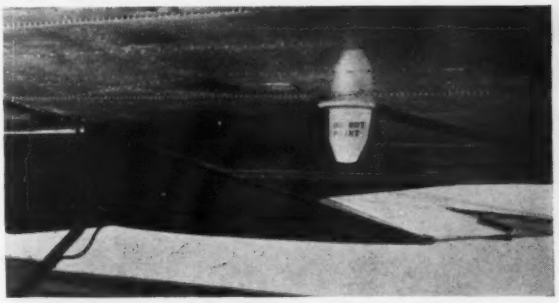

FIG. 2. DME antenna installation, C.A.A. aircraft N-9.

When the DME is associated with the Instrument Landing System, there is a requirement for high accuracy of indication at perhaps one or two points in the final approach. The first would probably be the last point at which a pull-out could be made; and the second, the point at which final flare-out should be started for a completely automatic landing. Both of these are obviously required to high precision, probably ±1,000 ft. for pull-out and ±50 ft. for starting the flare-out.

From this discussion, it becomes apparent that we have two very high accuracy requirements: one, the ground-speed indication; and two, the instrument approach indication for flare-out. With presently developed equipment, it is impossible to meet the extremely high precision requirements. This is regrettable, but the techniques used do not permit this. It would then seem to come down to an economic matter of just how much you are willing to pay for accuracy, for there is a considerable difference between an accuracy of, say, $^1/_2$ per cent of distance to an accuracy of 5 per cent of distance. From the considerable study that has been given to this problem, it appears that an accuracy of the order of 3 per cent of distance can be achieved quite economically and seems to satisfy the operational requirement for navigation and traffic control.

So far as the highly accurate requirements on final flare-out is concerned, we shall probably look to auxiliary means to give this indication. One means is the use of a marker. This marker could be the present 75-mc. marker. Another means could be by measurement of altitude above terrain. So far as highly accurate ground-speed determination is concerned, this is an auxiliary use of DME, and it is questionable whether extremely high accuracy is worth the cost. Three per cent accuracy should give ground speed five to ten times as often as it can be obtained today, and with like precision.

During this discussion on accuracy of indication, it has occurred to you, perhaps, that something may slip or go wrong in the equipment, which would cause an erroneous indication to be given to the pilot. While a

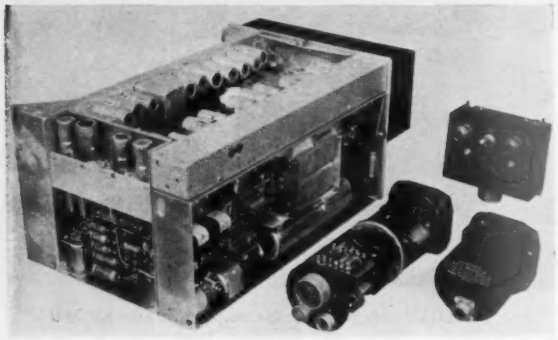

FIG. 3. DME interrogator (case removed).

flag-alarm-type of indication will be employed, it is not completely "fail-safe." We believe from the development and engineering that has gone into this equipment that possibility of gross error is extremely remote. It should be stated that, of course, it is possible, as it is with every form of air-derived data, such as the receivers for VOR, ILS, air-borne radar, etc. However, there are several cross-checks that can be used. One is the check with markers, as was mentioned previously. Another is the fact that when the system is fully implemented, there will undoubtedly be several stations within line of sight so that an intersection from the bearings of two VOR-DME stations can be obtained and compared with the distance reading from these stations. To attempt to put into the air-borne equipment a completely "fail-safe" reading of the distance-measuring circuits would perhaps require an equipment again as large as the DME itself. There obviously is a point of diminishing returns in this sort of cross-checking, and it is believed by those who have studied the equipment and flown it, that an auxiliary means will suffice.

Up to now, I have purposely avoided discussing what type of distance measurement we were considering. Quite obviously, the distance that the equipment is measuring is the slant distance, or, in other words, the direct distance from the aircraft to the station. At low angles of elevation, this slant distance is, for all intents and purposes, equivalent to the horizontal distance over the ground. However, as the aircraft approaches the

FIG. 4. VOR-DME antenna installation.

station and, as mentioned previously, when it is directly over the station, this distance is no longer the horizontal distance but is actually an altitude measurement of the aircraft's height above the station. There has been considerable discussion and thought given to whether an altitude correction should be introduced into distance indication, especially when using the Computer. Let us look at a few figures. Should the spacing of parallel airways be in the order of 15 miles, then an aircraft passing 15 miles to the side of a VOR-DME station at 20,000 ft., let us say, will actually come in only one-half mile closer to the station than if there had been altitude correction. At lower altitudes, this distance will, of course, be less. In the ultimate system, where the proposal is to have parallel airways spaced 4 miles apart at the same altitude level, such slant range correction is a requirement. If an aircraft were to fly 4 miles from a VOR-DME station at an altitude of 20,000 ft., it would actually swing directly across the top of the station as it passes by, if there were no slant-range correction.

Number of Operating Channels

Perhaps a brief word on the number of channels that are required in the distance-measuring equipment would be helpful at this time. You know that the VHF navigation band has 100 channels available. These have been divided so that 60 are assigned for VOR and 40 for the localizer of the ILS. How many channels, then, should the DME have? The first equipment had only one. It obviously would not suffice. On the other hand, there was considerable discussion whether a full 100-channel equipment was required for operation in the United States. This discussion was based primarily on two factors. The first was doubt whether all 100 VHF navigation channels would actually be used. There now seems to be no doubt that all 60 VOR channels and at least 20 of the localizer channels will be employed during the transition period. With this planning, and with the knowledge that 100 channels are available, it seems fairly obvious that sooner or later they will all be put to use. As you all know, we have never yet had an equipment in an aircraft which had too many frequency channels. In fact, long before the equipment could be obsoleted, the number of channels has been far too few.

The second reason for fewer channels in the DME was based on its search limitation. It was believed by some that you could use one DME channel with two or more VOR or localizer channels. The distance of search of the DME could be limited so that although another station was on the same DME channel, it could not be picked up if more than twice the search distance away. However, if you wish to search to 200 miles, then the co-channel stations must be separated by something greater than 400 miles. Since this is the separation now used for VOR's, one DME channel could not be used with two VOR channels. Although doubling up might have been possible with ILS-DME channels, greater safety would be achieved on a one-to-

one pairing basis. It was concluded that the DME should have the same number of channels (100) as the VHF navigation system.

In air-line aircraft and in certain military aircraft, a common control head is planned so that the setting of a VOR frequency channel will also set the DME channel corresponding to it and the choice of a localizer frequency will also tune in the DME channel as well as the glide-slope receiver channel. This should insure that all navigation information is coming from the same site.

Identity

As you know, there is an identification code on the VOR and also on the localizer to serve as a cross-check that you are receiving the correct station. The problem of identity was present on DME as well, even when a common control head was used. There are four main reasons for requiring identity. The first is to determine that the receiver has been tuned to the proper station. You may inadvertently misset the control knobs and even a recheck of the setting may fail to detect the error. In other words, you may think you are setting to 113.5 mc. when actually you have set to 115.3 mc. It is felt that the identity code would be a means of calling this to your attention. The second reason is that the remote-control tuning mechanism may not function properly since there is no repeat back. It may have failed to notch over, and, consequently, the identity code would indicate that you were tuned to the wrong station. The third point is that the distance may be picked up from one point and bearing information received from another. There are certain conditions under which this can happen, and, although they are not likely to occur in normal conditions, the identity code would serve as a check on this. And lastly, the identification code is needed for station identification where the DME transponder is installed by itself.

It soon became apparent that the obtaining of an identity code on DME actually required more information transmission than for distance measurement, and voice transmission was completely out of the picture. What then could be done to obtain identity on DME? The bandwidth or intelligence capability of the system could be increased. This would be costly of spectrum and would be, in effect, having the tail wag the dog. On the other hand, the rate of transmission of identity could be slowed down to where its intelligence could be spread over a longer period of time and, hence, require no more bandwidth than for distance measurement alone.

As you might expect, the latter was chosen. Since the rate had to be slowed down so much, only a single long dash will be transmitted by the DME. Simultaneously, a similar long dash will be sent from the VOR or Localizer. When this follows the normal VOR or Localizer code, the combination satisfies the first three reasons for requiring identity. The pilot should then hear only one dash if he is receiving VOR and DME data from the same site. Where the DME transponder is installed separately, a slow Morse code will probably be used to satisfy the last requirement.

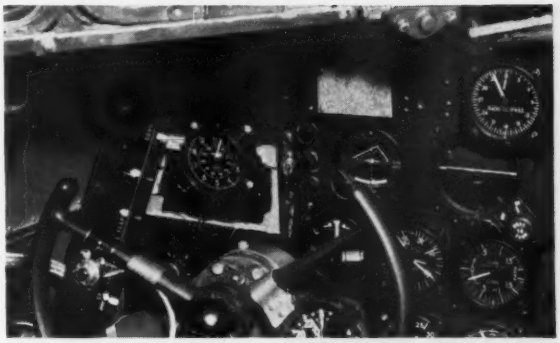

FIG. 5. DME installation aboard C.A.A. aircraft N-9 (instrument panel).

Traffic-Handling Capacity

A point which arises with the DME, but which is not present with a radio range, VOR, or ILS, is traffic-handling capacity. Quite obviously the traffic-handling capacity of a VOR is limited only by airspace separation conditions. You can have as many receivers as you like tuned to the transmitter, as you do with home receivers tuned to a broadcast station. However, with the distance-measuring equipment, you are actually interrogating the transponder and then listening to its reply. It can only listen to so many interrogations in a given period of time. This places a limitation on the amount of traffic that a single ground station can handle. In the case of the DME transponder situated with VOR's, it is believed that a traffic-handling capacity of 50 aircraft should be the design figure. It is realized that in certain heavy-density areas this might be surpassed, but in those instances either another navigation facility or the use of dual ground transponders, which time-share, could be employed.

With the DME transponder associated with ILS, the traffic-handling requirement would not, at first, appear to be as great. Only a small number of aircraft would be in the final holding stack and on final approach at any one time. However, there is another source of loading of the ILS transponder. You will undoubtedly want an extremely quick means of checking the equipment in aircraft prior to take-off. Test equipment would be costly and would not be simple to operate. It is quite simple to tune to the localizer DME channel, note the reading on the distance indicator, and check the identification code. This can give a complete overall indication of how the system is working. You can then imagine the number of aircraft that could be interrogating this transponder from the various ramps about an airport; yet this transponder must not deny service to those aircraft coming in on final approach. For this reason, it has seemed that the traffic-handling capacity of the transponder associated with ILS should be equal to the traffic-handling capacity of the VOR transponder. This has other advantages in that one transponder can suffice for all installations, and, consequently, a reduc-

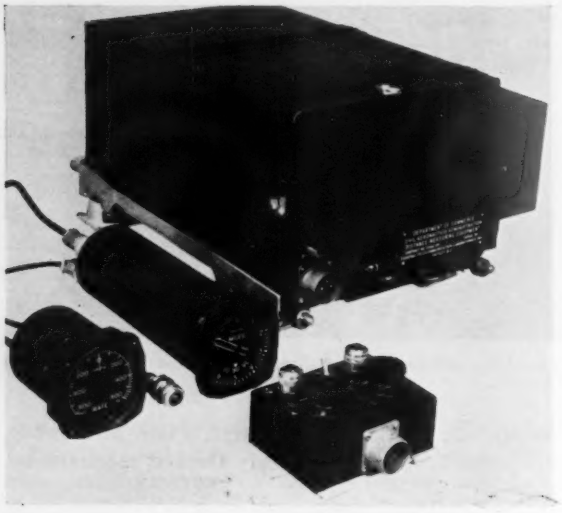

FIG. 6. DME interrogator (with case).

tion in production and installation costs should be realized.

Air-Borne Antenna

When measuring distance, the ground point may be at any bearing with respect to the aircraft. Consequently, the antenna coverage on the aircraft must be omnidirectional in the horizontal plane and essentially toroidal about the aircraft. To attempt to obtain this coverage, the antenna that will first be used is a half-wave vertically polarized dipole, which, at the DME frequency of about 1,000 mc., is only some 5 to 6 in. in length. This is enclosed in a streamlined housing, the housing being approximately 7 in. in length by some 3 in. in depth and about $^1/_2$ in. across the face. It has a drag of less than 1 lb. up to 400 m.p.h.

Another antenna that is being developed is entirely faired-in or flush with the skin of the aircraft. This antenna is about 10 in. in diameter and requires a depth of some 4 in. beneath the skin. To date, the half-wave dipole has been found to operate most successfully on a DC-3 when mounted on the belly slightly aft of the trailing edge of the wing. The flush antenna can also be mounted on the belly of the aircraft or underside of a wing.

Considerable thought has been given to multiple antenna installations since complete coverage is not possible on certain types of aircraft with one antenna. Shadow effect is more serious at 1,000 mc., since the aircraft is ten times as large in electrical wave length as it is in the VHF band. A great number of model range antenna tests must be made on various types of aircraft in the very near future to determine the optimum locations for the antenna. Undoubtedly these locations will be at the places most likely to affect the structural strength of the aircraft!

Radio Interference

You have all heard the virtues of very high frequency extolled from the standpoint of static reduction. DME, in the ultra-high-frequency band, is even better from this standpoint. However, this high frequency is not immune to ignition interference, as some have incorrectly assumed. The ignition interference in an aircraft seems to be a perfect built-in "jammer," and means must be taken to reduce the radiation from spark plugs, magnetos, and the like. Because of the fact that DME operates with pulses and has certain discrimination circuits that will accept only properly spaced pulses, it has a degree of immunity to ignition interference not found in continuous-wave or single-pulse equipments. The worst effect of ignition interference is to reduce the traffic-handling capacity of the system since the interference can be considered to load the channel excessively as would a large number of DME replies. Other aircraft equipment does not seem to bother the DME appreciably; rather, I think, the greater trouble may arise from DME interfering with other radio gear.

Service Conditions

In our designs to date, which are not pressurized, the distance-measuring equipment has not operated satisfactorily much above 25,000 ft. Further design will undoubtedly improve this condition, but it is important to realize that the voltages present in the distance-measuring equipment are considerably higher than those in VHF communication equipment. It is planned to pressurize the equipment for military use.

The variation in d.c. primary voltage supply can be quite great inasmuch as equipment will be engineered to handle large fluctuations. Temperature, pressure, and humidity variations, vibration, and shock should have little effect on its performance.

CONCLUSION

I hope this discussion of certain operational aspects of the DME has enabled you to obtain a better picture of the equipment and to appreciate some of the problems that will face you when it comes into operation. We in the Air Navigation Development Board would welcome any suggestions that you would care to make in regard to the performance that is expected from this equipment. We feel that it provides a necessary link that has been unobtainable to date. We are developing it for you, and we want it to do the things that will best serve your needs.

Evaluation Criteria for Transport Aircraft

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United Air Lines, Inc.

TRANSPORTATION, IN GENERAL, as an end product to be sold, cannot be seen or exhibited in advance. The quality of the product is judged on the bases of economy, safety, reliability, speed, comfort, and convenience. It is the purpose of this paper to list various criteria for evaluating the vehicle by which such a commodity is available. An attempt will be made to discuss each of these criteria to such an extent that their relative importance in the requirements of a specific operation may be weighed.

OPERATIONAL ECONOMICS

A consideration of the type of service to be rendered, whether the operation will be primarily one of passenger transportation or cargo transportation, the length of the route segments, the competition that exists both from other air carriers and from surface carriers, and the volume of business anticipated will in large part determine the general type of airplane that is required.

First Cost.—In addition to the first cost of an airplane, a realistic allowance must be made for the procurement of spare parts to start a new operation and to carry it throughout the first year. Allowance also must be made for ground equipment needed for servicing and maintaining the airplane and for handling passengers and cargo. The sum of these amounts constitutes the initial investment in equipment.

Cost of Introduction.—The cost of introducing a fleet of new airplanes into scheduled service is an item that has not been analyzed sufficiently to permit its prediction. It does, however, constitute a sizeable item. During the period of introduction, which is considered to last one year from the day on which the first schedule was operated, maintenance expenditures run appreciably higher than they do subsequently. Accordingly, a portion of the maintenance expense should be charged to this period. Schedule delays or cancellations result in loss of revenue which is attributable also to the introductory phase of operation.

Route Analysis.—All, or at least the critical, segments of a given scheduled operation should be analyzed in accordance with a form that lists for each route segment the block speed and schedule time required, the maximum pay load that can be carried, the pay-load limiting conditions applicable, the maximum revenue potential,

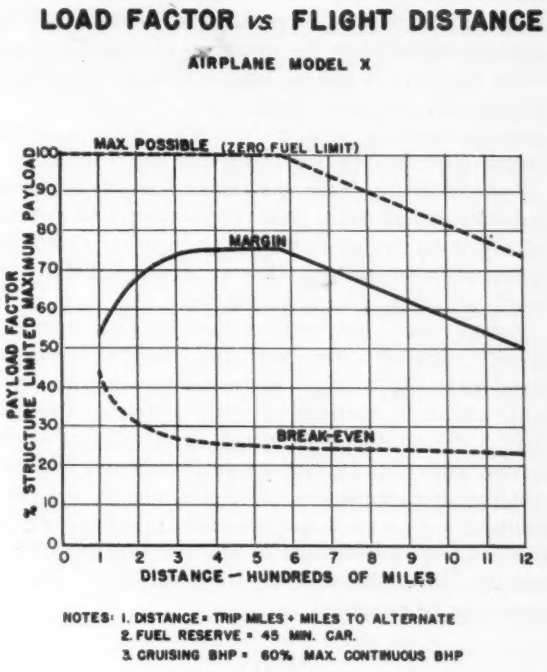

FIG. 1.

the direct operating cost, and the break-even load factor. Such an analysis indicates how effectively the airplane can be used in a system of schedules.

Direct Operating Expense.—If an airplane is to be used primarily on routes having poor traffic potential, minimum operating expense is the primary economic criteria. For most routes, it is desirable to have an airplane that provides for traffic development even though the operating cost may be proportionately higher. The equipment required on the ground for loading, unloading, and servicing the airplane should be considered along with the direct operating expense. For certain designs, the initial outlay can be considerable and the cost of maintenance quite high.

Break-Even Load Factor.—The break-even load factor is such an important item in the economy of operation that a separate discussion of load factors is justified. The concept preferred by the authors for aircraft evaluation purposes defines load factor as: the ratio of the actual load carried to the difference between the structurally limited gross weight for zero trip length and the operating weight empty. A given airplane operating at the same pay-load factor over any two or more route segments carries the same total pay load under this definition. Further, the maximum possible pay-load factors, computed in route analysis, give a direct indication of

Condensation of a paper presented at the Air Transport Session, Seventeenth Annual Meeting, I.A.S., New York, January 24–27, 1949. Complete paper is available as I.A.S. Preprint No. 206.

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‡ Aeronautical Engineer.

the penalty imposed on an airplane by the limitations of specific route segments.

Fig. 1 contains curves of maximum possible load factor versus flight distance and of break-even load factor vs. flight distance. The differences between the ordinates of these two curves are used to plot a third curve, margin pay-load factor vs. distance, to indicate the proportion of pay load remaining to meet indirect expenses and to yield a profit. This third curve is of reference value when the frequency of operations over route segments of various lengths is being established for schedule purposes. Such a plot does not take the place of complete route analysis when some segments impose other than the basic structural limitations.

Indirect Costs.—Since the costs of advertising and publicity and of traffic, sales, engineering, and general administrative expenses may vary from one transport organization to the next, they are not included in the basic evaluation of a given airplane.

Return on Investment.—Characteristic "earning power" curves for some currently operated airplanes are given in Fig. 2. Fig. 2 is a plot determined from actual operating statistics of three different airplane fleets. It is possible to draw such curves of anticipated earning power for aircraft not yet in schedule. If the manufacturer supplies complete cost, weight, and performance data, a route analysis can be prepared. From this and from a knowledge of how the airplane will be scheduled over the air line, the anticipated earning power can be computed.

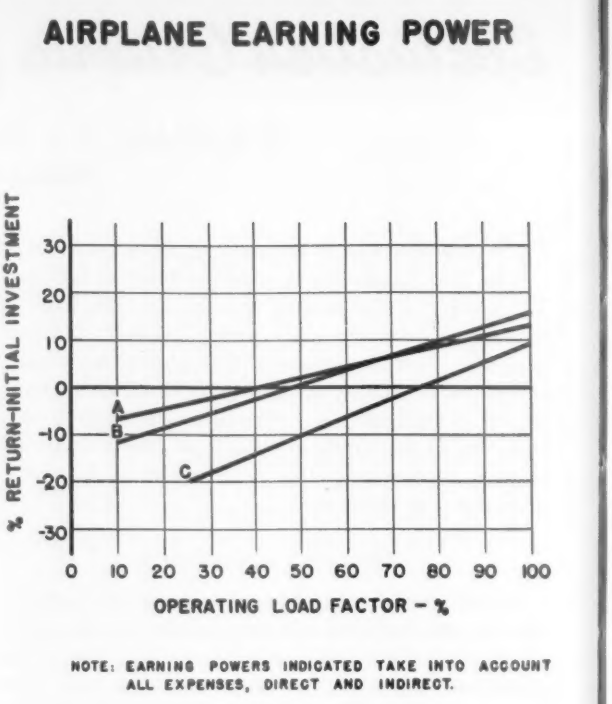


FIG. 2.

SAFETY

An analysis of the airplane from the standpoint of the personnel procedures, both normal and emergency, required to operate it should be made. Operating procedures that require the participation of personnel other than to direct the course or to regulate the speed of flight are signal evidence of inadequacy of design.

The operator should investigate the flight characteristics thoroughly. The Civil Air Regulations are minimum requirements and, therefore, do not necessarily represent the operator's desires. The operator must determine the degree of compliance possessed by the airplanes being considered. There are various characteristics that may contribute to pilot fatigue or to the complexity of piloting procedures.

Design details, particularly those of equipment and equipment installation, which influence the probability of the occurrence of fire should be subject to the closest scrutiny.

PERFORMANCE

There must be adequate separation between the minimum and maximum usable cruising speeds to ensure flexibility for the purpose of maintaining on-time schedule reliability in the face of varying wind conditions. Differences in time for taxiing and run-up and in-climb performance make the block-speed comparison of greater importance than a strict comparison of cruising speeds. Landing aids have lessened the requirement that an airplane be able to maneuver readily and make approaches under conditions of poor visibility. However, the requirement has not been eliminated, especially for the airplane designed for short-haul operation. Weight restrictions imposed by performance requirements of the Civil Air Regulations must be closely scrutinized. For certain operations, these restrictions may prove to be limiting rather than the structural limits. The basis for determining the airport and climb performance should also be examined. Basic performance deficiencies may be obscured by various expedients, such as restricted c.g. movement and variable flap settings. Although these expedients aid in removing certain weight restrictions, they introduce undesirable complexities of loading and piloting procedures.

WEIGHT—BALANCE

Loading.—The range of permissible c.g. movement must be carefully examined. The per cent M.A.C. movement necessary for unrestricted loading must be greater for planes of high wing loadings and high aspect ratios. In some instances a large c.g. movement is meaningless because of an inherent tail- or nose-heavy condition. Sample loading charts should be calculated in order to determine the actual balance restrictions, if any. Passenger loading should be unrestricted, and the restrictions on cargo loading should be at a minimum.

Pay load.—Pay load, that portion of the load from which revenue is derived, is determined from the following: Pay load = limiting gross weight − fuel − operating weight empty.

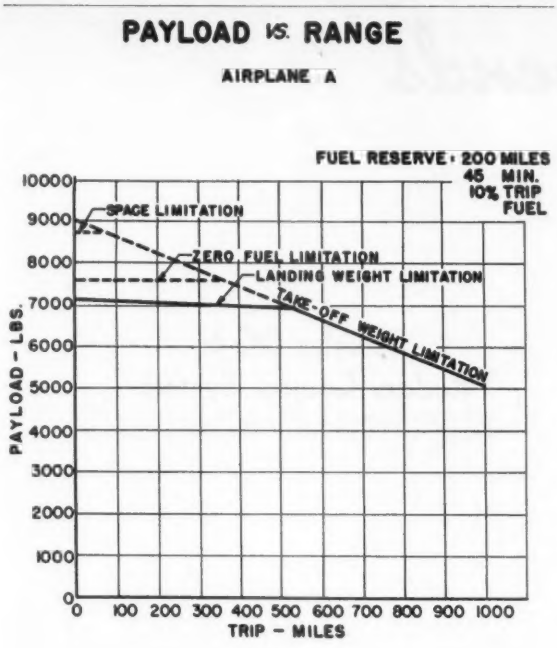


FIG. 3.

The operating weight empty is defined as: operating weight empty = manufacturer's weight empty + crew + equipment + oil. The crew weight includes crew baggage. The equipment weight includes food, blankets, pillows, etc.

Pay-Load Restrictions.—On most current planes, the fuel is located in the wings and does not contribute to the wing-root bending moment. Because of this, the concept of maximum permissible zero fuel gross weight has been introduced and is one of the structural limitations. Other structural limitations on the pay load are the maximum permissible take-off and landing gross weights and the maximum floor loadings. Runway requirements for take-off and landing, and the climb requirements for take-off enroute, approach, and landing configurations are a second group of limitations that sometimes restricts the pay load. Space limitations must be based on statistical data for the routes under consideration. It might well be that a standard-size package can be developed which can be used to determine maximum possible cargo-pit utilization.

Fig. 3, known as the Pay-Load-Range Curve, shows the effect of the structural and space limitations on maximum pay load for trips of various lengths. The maximum permissible landing gross weight in this example is the most restrictive for the shorter trip lengths because of the reserve fuel that must be aboard upon reaching the destination. If the alternate airport were located in the vicinity of the destination, the zero fuel structural limitation would become limiting rather than the maximum permissible landing gross weight. The point at which the take-off weight becomes limiting is known as the range for maximum pay load. This point should not fall within distances of the proposed normal operation.

Customer Reaction

Upon the items affecting the reaction of the customer (passenger or shipper) to the airplane, largely depends the ability to attract repeat business.

Air conditioning of aircraft involves the control of temperature, ventilation, pressurization, and humidity. Temperatures are currently maintained between 70 and 75°F. Ventilation should be at a rate between 30 and 40 cu. ft. per min. of air of sea-level density per passenger. Air velocities should not exceed 40 ft. per min., and the cabin pressure altitude is generally not permitted to exceed 8,000 ft. Humidity in the range of 25 to 40 per cent has been indicated as preferred. The average noise levels for long-range aircraft should not exceed 60 db. in the 1,200–2,400-cycles-per-sec. octave band. Full consideration should be given to minimizing both noise and vibration in the very early stages of development. To be judged comfortable, the maximum vector amplitude should be kept under 0.002 in. for frequencies above 20 cycles per sec., according to data listed by McFarland.

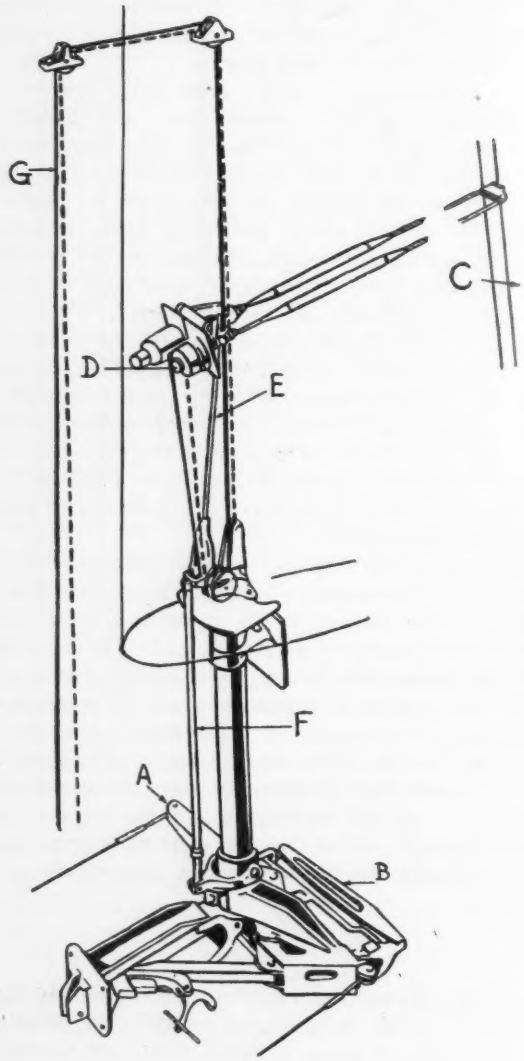
Passengers' reactions may be psychologically adverse to disturbing movements resulting from poor ride qualities. Interior illumination, if inadequate, is quickly detected by passengers desiring to read. The direction and distribution of light are just as important as intensity. The ratio of sky brightness to interior brightness must also be appraised. The adequacy of items provided to meet the needs and convenience of passengers or to provide entertainment for them has a definite bearing on the final attractiveness of the service. In cargo transport, the facilities for securing, segregating, and preserving shipments may offer decided sales advantages.

Maintenance

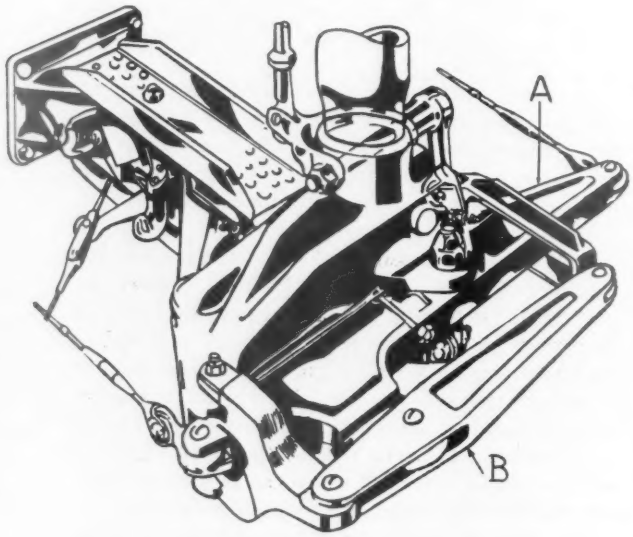
A point for emphasis is the importance of minimizing the time that an airplane must spend on the ground. Ground time is a larger economic factor with modern high-speed transports than it has been for preceding types. The interests in facilitating production, on the part of manufacturers, and in minimizing maintenance problems, on the part of operators, often conflict. The best overall compromises in such instances result from close liaison between factory and air-line representatives.

Design Trends

Douglas DC-6
Rudder Control System

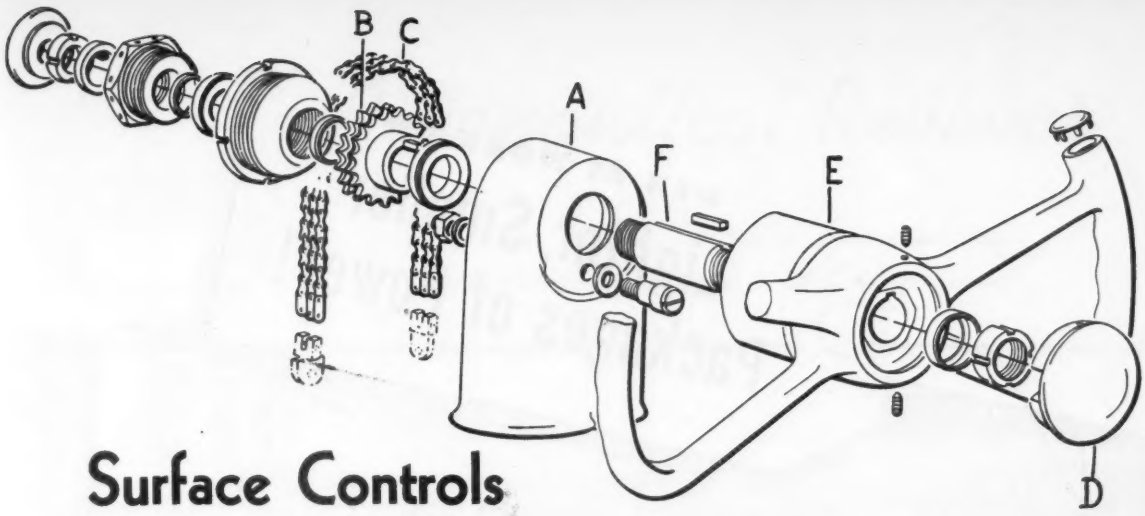


Rear View of Lower Part of Spring Tab Mechanism

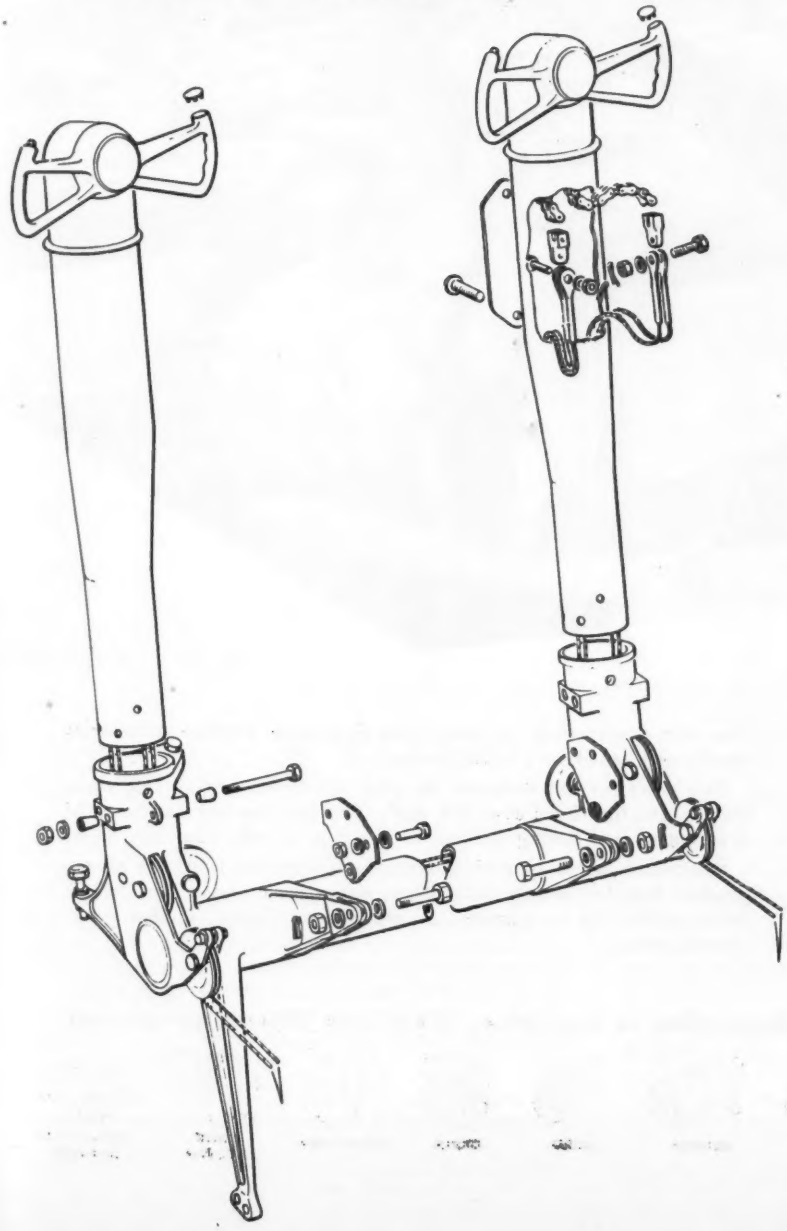


Rudder and Tab Control: *In flight, movement of the walking beam (A) engages the rudder actuating horn, moves the rudder spring control walking beam (B), and actuates the rudder tab (C) through linkage. As the rudder responds to the controls and the air load is built up on the rudder, the tab will move in the opposite direction, giving the pilot, through the leverage exerted, aerodynamic assistance for the movement of the rudder. The spring control tab mechanism is located at the base of the rudder and is connected to the trim-tab drive mechanism (D) by means of two vertical rods. One rod (E) is attached to the trim-tab drive mechanism and to a bell crank at the top of the rudder torque tube; the other rod (F) is connected at the torque-tube base and to the bell crank at the top.*

Trim Tab Drive Mechanism: *The rudder trim-tab drive mechanism consists of a housing assembly bolted to the rudder structure, two aluminum-alloy die-cast drums, which rotate on bearings on the housing, and a spring-loaded reciprocating piston attached to the tab actuating push rod. Cables (G) from the flight compartment enter the housing and wrap around and interconnect the two drums, thereby actuating the reciprocating piston through the spring, which positions the tab when it is used to trim the airplane. Interior mechanism of the piston assembly is protected from dust by a neoprene boot at its aft end and by an extruded dust cover at its forward end.*



Surface Controls



Martin 2-0-2 Control Column & Head

Head: *The Martin 2-0-2 control-column head (A) is of simple design, containing the sprockets (B) mounted on the wheel shaft and engaging short lengths of chain (C) to which the aileron cables are attached. The wheel, to which is screwed the cap (D), is attached to the hub (E) mounted on a spindle (F).*

Column: *The dual control columns are tubular members containing the aileron cables and chains in parallel connected pairs. Cables are accessible by removing plates on the control column. The left-hand column has an extension arm below its axis. This arm is connected to the upper elevator cable. Elevator cables form a closed loop, ends of which are connected to the extremities of the elevator cable arm which functions as a quadrant.*

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Aeronautical Reviews

A Guide to the Current Literature of Aeronautical Research and Engineering

I. PERIODICALS AND REPORTS

The abstracts are classified according to the Standard Aeronautical Indexing System. Numbers in parentheses indicate the position of the Division Headings in the numerical arrangement. Headings marked by an asterisk have not yet been established by the S.A.I.S.

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Aerodynamics (2)

BOUNDARY LAYER

Monograph VI; Stability of the Boundary Layer. P. Chiarulli and J. C. Freeman. *U.S., Air Force, Technical Report No. F-TR-1197-IA*, August, 1948. 104 pp., figs. 61 references.

CONTROL SURFACES

High Lift Devices and Their Uses. R. R. Duddy. *Royal Aeronautical Society, Journal*, Vol. 53, No. 465, September, 1949, pp. 859–884, Discussion, pp. 885–900, figs. 6 references.

Difficulties of maintaining trim and stability are the principal aerodynamic problems to be overcome in the application of high-lift devices. Full-span leading-edge slats are effective in providing high lift and low drag for improved take-off and climb. Maximum lift coefficients are readily available with conventional aircraft layout and controls. Best results in minimizing flap drag to meet airworthiness requirements are obtained with single slotted and Fowler flaps, and increasing the flap span is effective in reducing the overall drag, especially at high lift coefficients. Large values for the tail volume result in minimum trim changes when the pitching moment due to the flap is large; ground effect is not serious if the use of high-lift flaps is combined with large tail volume; and lift losses due to trimming can be kept small. Use of flaps to give optimum lift coefficient reduces take-off distance by more than 35 per cent. For take-off with power loading of 10 lbs. per b.hp. maximum lift coefficient is about 2.8 for four-engined aircraft and about 2.0 for twin-engined craft. For landing with power loading up to 12 lbs. per b.hp. it is feasible to use lift coefficients of at least 3.5. With sweptback wings the lift increments due to flaps are smaller and it is more difficult to maintain trim without serious loss of lift. A trimming tailplane apparently is required if the maximum lift coefficient is to exceed 1.2.

Stuurkrachtversterkers (Assisted Control). III—Stuurmachines (Power Operated Flight Controls). A. J. Marx and J. Buhrman. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. V.1431*, December 31, 1947. 22 pp., diagrs. 9 references. (In Dutch.)

An examination of flight-control mechanisms actuated by hycraulic or electrical power assumes that it is desirable to provide the sense of "feel" in the operation of the controls. The advantages of control without that degree of sensitivity also are considered. Aerodynamic and mechanical methods of servo-control for lightening the physical effort required in flying large and fast aircraft are studied, as well as the theoretical aspects of control with stick, wheel, or pedal free. The use of power boost does not affect adversely the flying characteristics of the airplane.

Investigations on the Stability, Oscillation, and Stress Conditions of Airplanes with Tab Control. Second Partial Report—Application of the Solutions Obtained in the First Partial Report to Tab-Controlled Airplanes. B. Filzek. (*ZWB Forschungsbericht Nr. 2000/2*, November 15, 1944.) *U.S., N.A.C.A., Technical Memorandum No. 1198*, September, 1949. 47 pp., figs. 12 references.

FLUID MECHANICS & AERODYNAMIC THEORY

Wave Action Following Sudden Release of Compressed Gas from a Cylinder. F. K. Bannister and G. F. Mucklow. *Institution of Mechanical Engineers, Proceedings*, Vol. 159, *War Emergency Issue No. 42*, 1948, pp. 269–287, Discussion, pp. 287–300, illus., diagrs., figs. 6 references.

The theoretical investigation involved sound-wave limitations and the work of Earnshaw and Riemann in relation to the propagation under frictionless conditions of waves of finite amplitude, extending the Aschenbrunner theory of pressure equalization in a semi-infinite pipe to cover discharge from a cylinder into a pipe of the same bore or to atmosphere. Application of the accepted mathematical solution of the analogous electrical transmission-line problem to the case of small-amplitude waves led to the deduction of a hyperbolic law defining the effects of friction. The arguments developed in the theoretical examination were applied to discharge from a cylinder through an orifice of diameter smaller than that of cylinder. Experimental apparatus consisted of cylinders of 2-in. bore and from 1 ft. to 40 ft. 6 in. long, from which air at gage pressures ranging from 140 lbs. per sq. in. to −25 in. of mercury was discharged either directly to atmosphere or through a pipe of 2-in. bore and up to 81 ft. in length. Indicator diagrams were recorded at points spaced along the cylinder and pipe, and corresponding diagrams also were obtained by using a cylinder 4 ft. long and of 4-in. diameter in conjunction with a pipe of 2-in. bore. General agreement between the theoretical and experimental investigation shows that the discharge processes under the conditions considered are explainable under accepted physical laws, and experimental confirmation is obtained for the theoretical treatment by Giffen for discharge from a cylinder through an orifice of smaller diameter. Quantitative data are given in regard to propagation velocities, pressure amplitudes, attenuation, etc.

Some Remarks on the Theory of Near-Sonic, Near-Parallel Flow and Its Application to Channel Flow. R. Timman. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. F.53*, January 6, 1949. 14 pp., fig. 5 references. (In English.)

Introducing the Von Kármán-Guderley simplifications, which are valid in the neighborhood of the sonic line, a calculation is made of the field of flow in a Laval nozzle. The conditions near the throat are investigated, starting from the hodograph plane, and solutions of the problem are given in terms of associated Legendre functions of the order $^1/_3$.

The Calculation of Compressible Fluid Flow by the Use of a Generalized Entropy Chart. J. Kestin and A. K. Oppenheim. *Institution of Mechanical Engineers, Proceedings*, Vol. 159, *War Emergency Issue No. 43*, 1948, pp. 313–334, figs. 16 references.

If the conditions in the reservoir from which a gas is to be discharged are known, the complete conditions at any given cross section may be read directly from the chart when two parameters at the section considered are specified. The parameters may include the velocity, pressure, density, temperature, local Mach Number, local sound velocity, cross-section area, mass flow per unit area, momentum per second, etc. The method is not confined to isentropic flows and may be applied to such problems as the flow in straight pipes or convergent and divergent nozzles including losses by either friction or condensation shocks. The coordinates of the chart are dimensionless entropy and dimensionless enthalpy, and all other variables are expressed in terms of those two coordinates. Tables for several values of the ratio of specific heats are given to facilitate the drawing of such charts.

Volterra's Solution of the Wave Equation as Applied to Three-Dimensional Supersonic Airfoil Problems. Max. A. Heaslet, Harvard Lomax, and Arthur L. Jones. *U.S., N.A.C.A., Report No. 889*, 1947. 22 pp., illus., diagrs., figs. 13 references. U.S. Govt. Printing Office, Washington. $0.20.

The Reversibility Theorem for Thin Airfoils in Subsonic and Supersonic Flow. Clinton E. Brown. *U.S., N.A.C.A., Technical Note No. 1944*, September, 1949. 9 pp. 9 references.

Readers' Forum: On the Compressibility Correction Factor for Axially Symmetric Bodies. A. D. Young. *Journal of the Aeronautical Sciences*, Vol. 16, No. 11, November, 1949, p. 703. 2 references.

On a Complete Solution of the One-Dimensional Flow Equations of a Viscous, Heat-Conducting, Compressible Gas. Morris Morduchow and Paul A. Libby. *Journal of the Aeronautical Sciences*, Vol. 16, No. 11, November, 1949, pp. 674–684, 704, figs. 12 references.

On Shock Waves in Inhomogeneous Flow. Mac C. Adams. *Journal of the Aeronautical Sciences*, Vol. 16, No. 11, November, 1949, pp. 685–690, figs. 5 references.

Theoretical Study of Air Forces on an Oscillating or Steady Thin Wing in a Supersonic Main Stream. I. E. Garrick and S. I. Rubinow. *U.S., N.A.C.A., Report No. 872*, 1947. 14 pp., figs. 21 references. U.S. Govt. Printing Office, Washington. $0.15.

Approximate Integration of the Equations of Supersonic Gas Flow. S. A. Christianovich. [*Prikladnaia Matematika i Mekhanika* (*U.S.S.R.*), Vol. 11, 1947, pp. 215–222.] *U.S., Air Force, Technical Report No. F-TS-1220-IA*, May, 1949. 18 pp., figs. 3 references.

Effect of Transverse Curvature on Frictional Resistance. L. L. Landweber. *U.S., Navy, The David Taylor Model Basin, Report 689*, March, 1949. 8 pp., diagrs. 4 references.

INTERNAL FLOW

Pressure-Distribution Tests and Investigation of Flow Pattern for Circular Air Intakes with Various Nose Profiles. S. Luthander, G. Axel, and T. Gullstrand. (*Royal Institute of Technology, Division of Aeronautics, KTH Report No. 93-22*), *Stock-*

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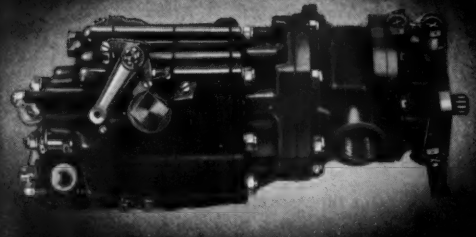

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DETROIT, 4

FOR HALF-A-CENTURY—ORIGINAL EQUIPMENT MANUFACTURERS FOR THE AUTOMOTIVE INDUSTRY

holm, Kungl Flyzförvaltiningen (Royal Swedish Air Board), Translation No. 4, 1948. 49 pp., illus., diagrs., figs. (In English.)

To aid in the selection of the best nose profile for an aircraft-engine air intake by observations of the flow conditions, a circular air-intake model was provided with three interchangeable nose-profile sections; the N.A.C.A. airfoil 2410-64 profile; a symmetrical, semielliptic profile; and a symmetrical, semielliptic profile superimposed on the mean line according to N.A.C.A. 3410-44 airfoil. Tests showed the danger of local high speeds on the outside of all the sections under high-speed flight conditions except in the case of the semielliptical profile based on N.A.C.A. 3410-44 at angles of attack from $-2°$ to $+2°$. For taxiing conditions a breakaway of flow occurred on the inside of the intake of all profiles and at all angles of attack, but did not appear at higher speeds corresponding to take-off or at normal flight speeds.

A Class of de Laval Nozzles. S. V. Falkovich. [*Prikladnaia Matematika i Mekhanika (U.S.S.R.)*, Vol. 11, 1947.] *U.S., N.A.C.A., Technical Memorandum No. 1236*, October, 1949. 15 pp., figs. 6 references.

On a Class of Laval Nozzles. S. V. Falkovich. [*Prikladnaia Matematika i Mekhanika (U.S.S.R.)*, Vol. 11, 1947, pp. 223–230.] *U.S., Air Force, Technical Report No. F-TS-1223-IA*, May, 1949. 15 pp., figs. 6 references.

Mixing of Any Number of Streams in a Duct of Constant Cross-Sectional Area. Roger Weatherston. *Journal of the Aeronautical Sciences*, Vol. 16, No. 11, November, 1949, pp. 697, 698, 704, fig. 3 references.

STABILITY & CONTROL

Investigations on the Stability, Oscillation, and Stress Conditions of Airplanes with Tab Control. First Partial Report—Derivation of the Equations of Motion and Their General Solutions. B. Filzek. (*ZWB Forschungsbericht Nr. 2000*, October 24, 1944.) *U.S., N.A.C.A., Technical Memorandum No. 1197*, September, 1949. 49 pp., figs. 12 references.

Stuurkrachtversterkers (Assisted Control). II—De Statische Langsstabiliteit van een Veerbalansvlak Voorzien Hoogteroer (The Effect of Spring Tabs on the Static Longituindal Stability). *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. V.1421*, September 3, 1947. 5 pp. (In Dutch.)

WINGS & AIRFOILS

Low Aspect Ratio Rectangular Wings in Supersonic Flow. P. A. Lagerstrom and Martha E. Graham. *Douglas Aircraft Company, Inc., Report No. SM-13110*, December, 1947. 29 pp., figs. 9 references.

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Airports & Airways (39)

The Aerodrome Problem Related to Aircraft Design and Operation. R. H. Ayers. *Royal Aeronautical Society, Journal*, Vol. 53, No. 465, September, 1949, pp. 901–905, figs.

Features of commercial-aircraft design which have an important bearing on problems of airport layout and operation are take-off and landing performance, stability on the ground with sufficient landing-gear strength to resist high cross winds, climbing and descent rates proportional to horizontal speed in order to give reasonable approach and take-off angles, and multiple-wheel landing gear to spread the landing impact and reduce the runway-strength requirement. Other design factors that affect airport operation are the provisions built into the aircraft for rapid loading and unloading of passengers, fuel, and cargo, to facilitate preparation for the next flight, and to permit high traffic-movement rates. Reduced aircraft noise during take-off and landing should be provided for in the design, in order to lessen objections of residents to the close-in location of airports to municipalities served. Location and distance from population centers, transportation facilities, weather conditions, economic considerations, routes, and aircraft types to be operated are among the deciding factors in airport building and operation. Although many military airfields were constructed in Great Britain for war purposes, extensive work and expenses are entailed in making them suitable for commercial use.

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Application of Electric-Analog Computers to Heat-Transfer and Fluid-Flow Problems. G. D. McCann, Jr. and C. H. Wilts. *Journal of Applied Mechanics*, Vol. 16, No. 3, September, 1949, pp. 247–258, illus., diagrs., figs. 6 references.

There are two general classes of mathematical problems encountered in science and engineering for which high-speed mechanical computation is required. One of these embraces those problems of such complexity that it is impractical to obtain even a few solutions by conventional analysis. In the other class are problems which may be of only moderate complexity, but in which it is necessary to obtain a large number of solutions before the results become of practical value. It is the intent of this paper to discuss some of the applications that have been made of the California Institute of Technology "electric-analog computer" to heat-transfer and fluid-flow problems of both of the classes mentioned.

Mechanical Computing Mechanisms. II. Robert R. Reid and Du Ray E. Stromback. *Product Engineering*, Vol. 20, No. 9, September, 1949, pp. 119–123, diagrs.

Equipment

Aircraft Ancillaries. C. A. H. Pollitt. *Aeronautics*, Vol. 21, No. 4, September, 1949, pp. 150, 153, 155, 156, 159, 160, 163, 164, diagr.

An extensive analysis of the design and operating characteristics and the advantages of the electrical, hydraulic, and pneumatic systems for actuating the controls and auxiliary power mechanism of military and civilian aircraft. The current trend is toward combinations involving electrical control of hydraulic or pneumatic systems.

Essential Services; Developments in the Major Components and Auxiliary Services Fields. *Flight*, Vol. 56, No. 2124, September, 1949, pp. 316–319, illus.

Round the Accessory and Material Stands (Farnborough Exhibit 1949). *The Aeroplane*, Vol. 77, No. 1997, September 16, 1949, pp. 401–406, illus.

HYDRAULIC & PNEUMATIC (20)

Hydrostatic Tests of High-Pressure Steel Valves and Fittings. Clayton L. Pittiglio. *U.S., Navy, The David Taylor Model Basin, Report No. 638*, May, 1949. 9 pp., illus., diagrs., figs.

Hydrostatic Tests of Low-Pressure Bronze Valves and Fittings. Clayton L. Pittiglio and James G. McGinley. *U.S., Navy, The David Taylor Model Basin, Report No. 637*, May 1949. 17 pp., illus., diagrs., figs.

Unorthodox Pneumatic Circuits Make Simple Standard Devices Perform Extraordinary Jobs. Ralph D. Webb. *Instruments*, Vol. 22, No. 8, August, 1949, pp. 675–678, diagrs.

Flight Operating Problems (31)

CLIMATIZATION

The War Against Winter. Neil Macdougall. *The Aeroplane*, Vol. 77, No. 1995, September 2, 1949, pp. 291–293, illus.

HIGH-ALTITUDE FLIGHT

40,000 Ft. for Civil Aircraft? W. A. Waterton. *Hawker Siddeley Review*, Vol. 2, No. 3, September, 1949, pp. 3–7, illus.

PILOTING TECHNIQUE

Oh, Clementine! Waldo E. Rassas. *Air Facts*, Vol. 12, No. 9, September 1, 1949, pp. 23–26.

Five experienced flight instructors had difficulty in passing the prescribed tests for precision or "spot" landings with a light airplane equipped with elaborate recording instruments. Changes in landing requirements for private pilots, allowing more freedom in methods, would result in greater safety.

Keeping Contact. Marion Hart. *Air Facts*, Vol. 12, No. 9, September 1, 1949, pp. 44–58, diagrs. Discussion of elementary meteorology and the effects of unstable air, clouds, air currents, fronts, and other weather phenomena.

The Instructor Flies Blind. John P. Weinel. *Flying*, Vol. 45, No. 4, October, 1949, pp. 30, 31, 68, illus.

How to Fly in Thunderstorms. *Flying*, Vol. 45, No. 4, October, 1949, pp. 21–23, 64, 65, illus.

No Advance in Aerobatics? *Aeronautics*, Vol. 21, No. 4, September, 1949, pp. 67–69, figs.

REFUELING IN FLIGHT

Fast Flight Fuelling. *Aeronautics*, Vol. 21, No. 4, September, 1949, pp. 58, 59, illus.

The Entomopter; Theory and Experiments. II—Fundamental Law of Entomoptetics or Law of Magnan. A. L. Jordanoglou. *American Helicopter*, Vol. 15, No. 9, August, 1949, pp. 15–19, illus., figs.

WEATHER HAZARDS

Flying Lab Tests Airline Radar. *Aviation Week*, Vol. 51, No. 16, October 17, 1949, pp. 28, 31.

Climate Unlimited. L. F. Tanberg. *Aero Digest*, Vol. 59, No. 4, October, 1949, pp. 52–54, 94–96, 98, illus.

Flight Safety & Rescue (15)

Accident Investigation in Relation to Aircraft Design. Vernon Brown. *Royal Aeronautical Society, Journal*, Vol. 53, No. 465, September, 1949, pp. 829–848, Discussion, pp. 849–858, illus., diagrs.

Well defined examples selected from Accident Investigation Board records show how the technical information obtained is being applied to the rectification of engineering causes of aircraft failure. Because most accidents have happened after the loss of flying control, the obvious remedy is to simplify aircraft design and thereby lighten the pilot's task. Structural failures in the air such as those due to defective nose riblets, slats, skin, control-cable tension attachment bolts, rudder and elevator controls, or propeller breakage have been remedied by appropriate design changes. Fires in flight were usually caused by leakage of inflammable fluid, incorrect location of piping and outlets, inadequate exhaust-system protection, or electrical faults. Improved fire-extinguishing equipment and design betterments solved those problems. Destruction following crash fires makes analysis difficult, but progress is being made in the design of fire-resistant components and better built-in automatic fire extinguishers. Proper cockpit layout, control-handle marking, and the elimination of toxic infiltration can prevent accidents attributable to pilot error or illness.

Safety Over Water. M. de Bunsen. *Aeronautics*, Vol. 21, No. 4, September, 1949, pp. 100–102, 105, 106, 114, 117, 118, diagrs., figs.

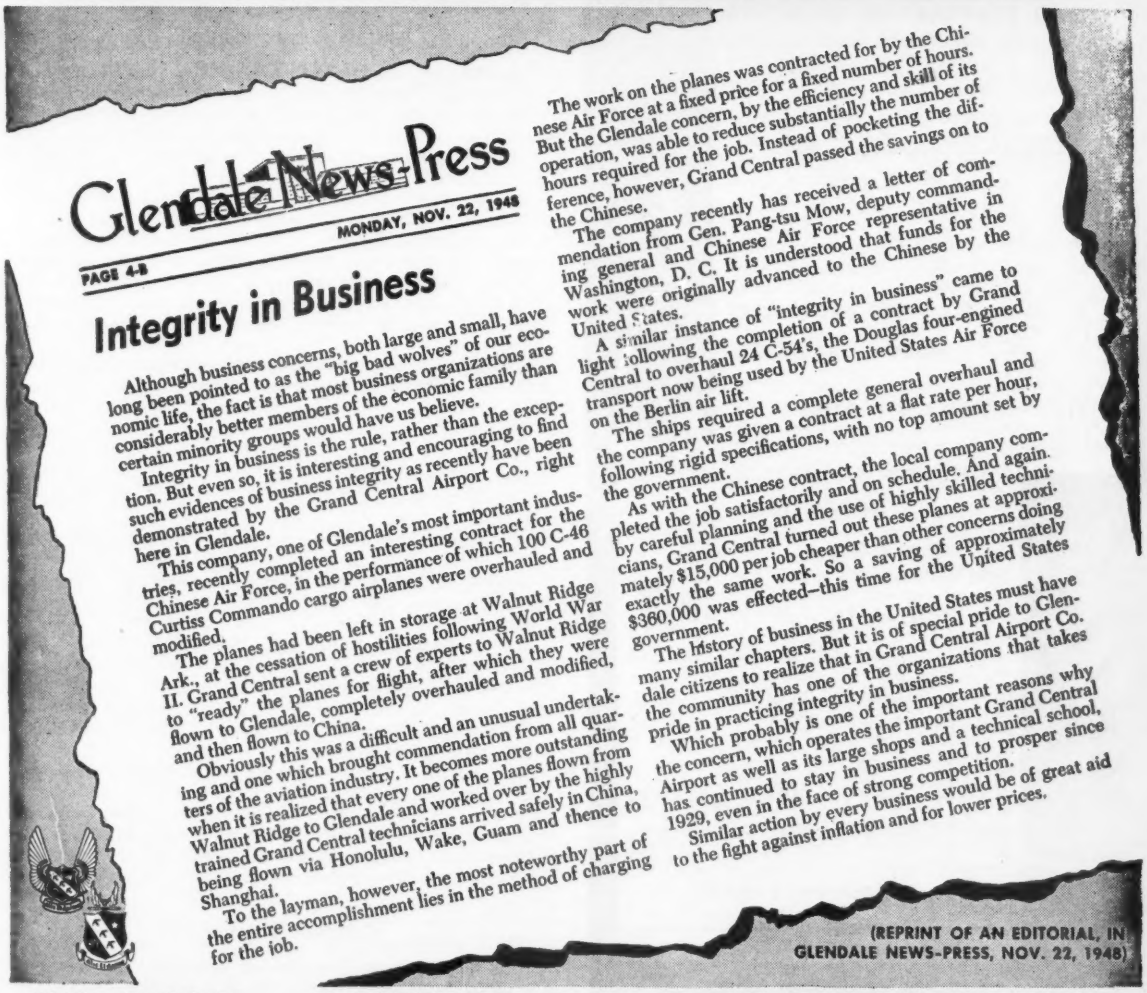
Most landplanes can be made reasonably safe for ditching if the design provides for sufficient structural strength and proper openings to avert rapid inrush of water, and for a good hydrodynamic shape and wing and tail layout to distribute the impact forces and prevent pitching or overturning. Interior layout and harness to avoid injuries, suitable escape hatches, life jackets, dinghies, survival and signaling equipment, food and water supplies, and necessary crew and passenger training will aid in lowering accident tolls. British search and rescue organizations have extensive facilities and equipment for dealing with overdue or lost aircraft, and they cooperate with government and international air-traffic and navigation-control units.

The Boeing Stratocruiser. *National Fire Protection Association, Committee on Aviation and Airport Fire Protection, Bulletin No. 37*, July, 1949, 16 pp., illus., diagrs. A training and information manual describes fire-detection and extinguishing apparatus, its use by flight and ground personnel, and rescue equipment and techniques.

Fire-Detection Philosophy. E. Hetzel. *Aero Digest*, Vol. 59, No. 4, October, 1949, pp. 44, 45, 105, 106, illus. Discussion of

WOULD YOU?

do business with THIS Company!



Glendale News-Press

MONDAY, NOV. 22, 1948

PAGE 4-B

Integrity in Business

Although business concerns, both large and small, have long been pointed to as the "big bad wolves" of our economic life, the fact is that most business organizations are considerably better members of the economic family than certain minority groups would have us believe.

Integrity in business is the rule, rather than the exception. But even so, it is interesting and encouraging to find such evidences of business integrity as recently have been demonstrated by the Grand Central Airport Co., right here in Glendale.

This company, one of Glendale's most important industries, recently completed an interesting contract for the Chinese Air Force, in the performance of which 100 C-46 Curtiss Commando cargo airplanes were overhauled and modified.

The planes had been left in storage at Walnut Ridge Ark., at the cessation of hostilities following World War II. Grand Central sent a crew of experts to Walnut Ridge to "ready" the planes for flight, after which they were flown to Glendale, completely overhauled and modified, and then flown to China.

Obviously this was a difficult and an unusual undertaking and one which brought commendation from all quarters of the aviation industry. It becomes more outstanding when it is realized that every one of the planes flown from Walnut Ridge to Glendale and worked over by the highly trained Grand Central technicians arrived safely in China, being flown via Honolulu, Wake, Guam and thence to Shanghai.

To the layman, however, the most noteworthy part of the entire accomplishment lies in the method of charging for the job.

The work on the planes was contracted for by the Chinese Air Force at a fixed price for a fixed number of hours. But the Glendale concern, by the efficiency and skill of its operation, was able to reduce substantially the number of hours required for the job. Instead of pocketing the difference, however, Grand Central passed the savings on to the Chinese.

The company recently has received a letter of commendation from Gen. Pang-tsu Mow, deputy commanding general and Chinese Air Force representative in Washington, D. C. It is understood that funds for the work were originally advanced to the Chinese by the United States.

A similar instance of "integrity in business" came to light following the completion of a contract by Grand Central to overhaul 24 C-54's, the Douglas four-engined transport now being used by the United States Air Force on the Berlin air lift.

The ships required a complete general overhaul and the company was given a contract at a flat rate per hour, following rigid specifications, with no top amount set by the government.

As with the Chinese contract, the local company completed the job satisfactorily and on schedule. And again, by careful planning and the use of highly skilled technicians, Grand Central turned out these planes at approximately $15,000 per job cheaper than other concerns doing exactly the same work. So a saving of approximately $360,000 was effected—this time for the United States government.

The history of business in the United States must have many similar chapters. But it is of special pride to Glendale citizens to realize that in Grand Central Airport Co. the community has one of the organizations that takes pride in practicing integrity in business.

Which probably is one of the important reasons why the concern, which operates the important Grand Central Airport as well as its large shops and a technical school, has continued to stay in business and to prosper since 1929, even in the face of strong competition.

Similar action by every business would be of great aid to the fight against inflation and for lower prices.

(REPRINT OF AN EDITORIAL, IN GLENDALE NEWS-PRESS, NOV. 22, 1948)

GRAND CENTRAL AIRPORT CO.

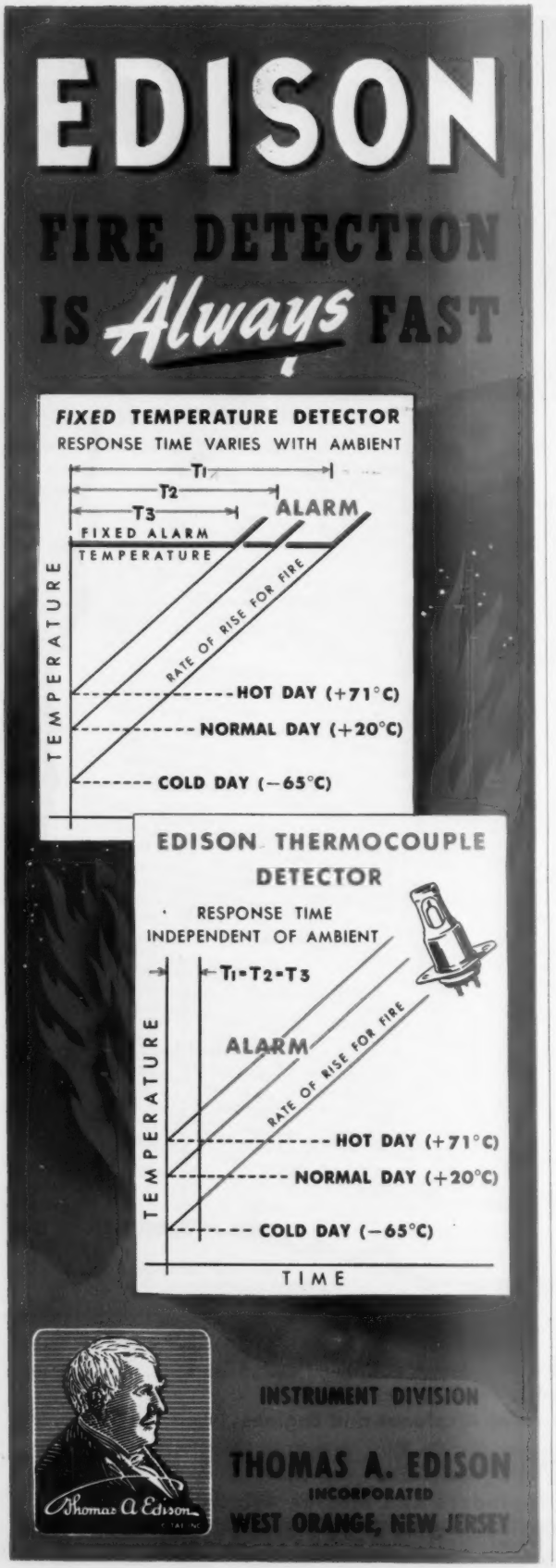
C. C. MOSELEY, PRESIDENT AND CHAIRMAN OF THE BOARD

Specializing in Overhaul, Repair and Conversion of Airplanes and Engines . . . *and its subsidiary*

CAL-AERO TECHNICAL INSTITUTE

Specializing in training of Aeronautical Engineers and Master Aviation Mechanics

GLENDALE, *(Los Angeles County)* CALIFORNIA



methods and devices for detecting and reporting excessive temperatures or flame presence in aircraft, and of means for avoiding false warnings.

Aircraft Proximity Indicator. Charles Adler, Jr. *Aviation Operations*, Vol. 12, No. 3, September, 1949, pp. 42, 43, figs. If all aircraft were equipped with a device that would warn pilots of the nearness of other aircraft, the hazards of mid-air collisions would be greatly reduced.

Evacuation of Aircraft Making Forced Landing. O. E. Kirchner. *SAE Journal*, Vol. 57, No. 9, September, 1949, pp. 44, 45, fig. (Extended summary of a paper.)

Science Versus Slipstream; A Note on the Developments Which Led to the Introduction of the Ejection Seat. J. E. Fricker. *Aeronautics*, Vol. 21, No. 4, September, 1949, pp. 123, 124.

The Flight Safety Service of (Swedish) Civil Aviation. J. G. Karlsson. *Saab Sonics*, No. 7, July–September, 1949, pp. 2–5, illus.

Combating the Fire Risk. *The Aeroplane*, Vol. 77, No. 200, October 14, 1949, p. 536, illus., diagr.

Fuels & Lubricants (12)

The Function of Additives in Aviation Oils. S. A. W. Thompson. *Shell Aviation News*, No. 134, August, 1949, pp. 18–20, illus., figs

Future Trends in Aviation Fuels. A. R. Ogston. *Air World*, Vol. 2, No. 2, September, 1949, pp. 34–38, illus., fig.

Synthetics Help Lubricate Military Airplanes. Bernard Rubin and Edward M. Glass. *SAE Journal*, Vol. 57, No. 10, October, 1949, pp. 58–60. 2 references. (Extended summary of a paper: The Air Force Looks at Synthetic Lubricants.)

The Oxidation, Ignition, and Detonation of Fuel Vapors and Gases. IX—The Cause of the Reversal of the Antiknock Property of Rich Hydrocarbon-Air Mixtures. R. O. King, W. A. Wallace, and E. J. Durand. *Canadian Journal of Research, Section F, Technology*, Vol. 27, No. 8, August, 1949, pp. 307–310, fig. 6 references.

The Shell-Ricardo Lubricating Oil Test Engine. *The Engineer*, Vol. 188, No. 4884, September 2, 1949, pp. 258–260, illus., diagr.

Gliders (35)

Aero-Hydro Glider Pickup Unit. Alexander Cowie. *American Society of Mechanical Engineers, Paper No. 49-F-10*, September, 1949. 30 pp., illus., diagrs., figs. (Preprint.)

A Canard Sailplane (Kaczka, Polish Experimental Glider). *Aeronautics*, Vol. 21, No. 4, September, 1949, p. 118, fig.

Soaring in France; The Saint Auban National Centre. Guy Borgé. *Sailplane and Glider*, Vol. 17, No. 9, September, 1949, pp. 194–196, illus.

The Production of the Slingsby 21B Sedburgh Glider; How the Problems of Small-Scale Manufacture in Wood Have Been Tackled at Kirby Moorside. J. C. Reussner. *Aircraft Engineering*, Vol. 21, No. 247, September, 1949, pp. 280–283, 286, illus.

Date with a Cloud. Scholer Bangs. *Interavia*, Vol. 4, No. 4, April, 1949, pp. 211–215, illus.

Explanation of the meterological conditions prevailing on the eastern slope of the Sierras near Bishop in southern California, where soaring pilots have established altitude records by using air currents associated with the formation of lenticular clouds. The sailplanes, instruments, equipment, and techniques employed in high-altitude soaring are described.

Guided Missiles (1)

The Establishment and Use of Artificial Satellites. Eric Burgess. *Aeronautics*, Vol. 21, No. 4, September, 1949, pp. 70–82, diagrs., figs. 3 references.

An orbital rocket could be developed within the next decade, of such form and character as to be fired from the earth at sufficient velocity to escape the gravitational pull and then to continue in motion around the earth for an infinite time in an orbit similar to that of the moon. Such an artificial satellite would have greater practical utility for research purposes than proposed efforts to send a rocket missile to the moon, and the difficulties would be no more severe. It is possible to calculate the velocities required and the influence of other celestial bodies such as the planets and the sun, as well as the size, position, and direction of the proposed artificial orbit. A rocket capable of transporting a satellite having a "pay

load" of 200 kg. and establishing it on an orbit at such distance from the earth that its period of revolution would coincide with the terrestrial day of 24 hours, would be of three-step construction weighing a total of 285,768 kg., with the final step unit about twice the size of the Wac Corporal rocket.

Castles in and Beyond the Air; The U.S. Earth Satellite Vehicle Programme. *Interavia*, Vol. 4, No. 4, April, 1949, pp. 187–190, illus. Brief comments on ancient fantasies regarding interplanetary travel and on the serious efforts of modern scientists in connection with the development of rockets and space vehicles.

The Research Scene. I. Kenneth W. Gatland. *British Interplanetary Society, Journal*, Vol. 8, No. 4, July, 1949, pp. 136–142, illus., diagr.

A review of recent progress in the development of guided missiles and equipment contains photographs taken from American A-4 and Aerobee rockets at altitudes of 60 and 70 miles above White Sands, New Mexico, as well as brief descriptions of the cameras used. A combination of the A-4 and the Wac Corporal rockets achieved an altitude of 250 miles and velocity of 5,000 m.p.h. The Viking rocket reached 51½ miles altitude in an initial test. Objectives of the Earth Satellite Vehicle Program of the U.S. National Military Establishment include research in astronomy, meteorology, radar, chemistry, biology, and possible observations of activities in foreign countries. The Rotochute is a large, hollow-nosed dart with two rotor blades that serve as air brakes to bring safely to earth research instruments and records discharged from high-altitude rockets.

The Model Programme. *British Interplanetary Society Journal*, Vol. 8, No. 4, July, 1949, pp. 162–165, diagr.

A rocket employing a hypothetical nuclear-powered propulsion unit is intended to form the basis for the design of a model to illustrate possible developments in space flight, especially a voyage around the moon. It would have chemical booster motors, an atomic-energy reactor, a three-step chemical crew rocket using liquid oxygen and hydrogen, and a pressurized chamber for the crew and instruments.

Rockets and Interplanetary Travel. Gerald Wendt. *SAE Journal*, Vol. 57, No. 9, September, 1949, pp. 29–33, illus., figs. (Extended summary of a paper.)

Astronautics; A Study. Mustafa Anwar. *Indian Skyways*, Vol. 3, No. 6, June, 1949, pp. 25–30.

Meteors as a Danger to Space-Flight. Arthur C. Clarke. *British Interplanetary Society, Journal*, Vol. 8, No. 4, July, 1949, pp. 157–162, figs. 3 references.

The Spaceship. Charles E. Wilson, Jr. *Rocketscience*, Vol. 3, No. 3, September, 1949, pp. 69–72, figs.

Gunnery and Guided Missiles; Fort Bliss Lays the Foundation for Developing New Ordnance Techniques. John L. Homer. *Ordnance*, Vol. 34, No. 176, September–October, 1949, pp. 99–101, illus.

The Rocket Plane. II. Hermann Oberth. (*Wege zur Raumschiffahrt., pp. 282–286.*) *Rocketscience*, Vol. 3, No. 3, September, 1949, pp. 57–59, 63.

Readying a Rocket for Launching Takes Expert Skill and Knowledge. Marvin Miles. *The Martin Star*, Vol. 8, No. 9, September, 1949, pp. 7–9, illus.

Rachemistry. IV. Alfred J. Zaehringer. *Rocketscience*, Vol. 3, No. 3, September, 1949, pp. 64–68, diagrs.

Control Constants of Guide Beam Signals Varying with Time for the V-2 Missile. Hoelker. (*Peenemünde, Arbeitsgemeinschaft Vorhaben, ZWB/PA/86/128*, June 11, 1943.) *U.S., Air Force, Technical Report No. F-TS-3007-RE*, August, 1947. 17 pp., figs.

Relationship Between Rudder Drive and Control Equation. Spehr. (*Peenemünde, Arbeitsgemeinschaft Vorhaben, ZWB/PA/86/127*, May, 1943.) *U.S., Air Force, Technical Report No. F-TS-2018-RE*, August, 1947. 8 pp., figs.

An Elementary Discussion of the Stability of Rocket Missiles at Subsonic and Supersonic Speeds. II—Stability at Supersonic Speeds. Donald J. Ritchie. *Rocketscience*, Vol. 3, No. 3, September, 1949, pp. 61–63, figs.

Guided-Missile Development. Clark B. Millikan. *Aero Digest*, Vol. 59, No. 3, September, 1949, pp. 38, 39, 102, illus.

Armed Forces Joint Proving Range for Guided Missiles Based on Florida Coast. *Journal of Southern Research*, Vol. 1, No. 4, October, 1949, p. 16, illus.

Short description of the research and testing facilities being installed by the National Military Establishment on the East Coast of Florida at the Banana River Naval Air Station, with firing ranges extending over a wide stretch of the Atlantic Ocean, and observation bases in the Bahamas.

Proving Ground for Rockets. Richard E. Stockwell. *Aviation Operations*, Vol. 12, No. 2, August, 1949, pp. 32, 33, 65–67, illus. Naval Air Station, Banana River, Florida.

Instruments

AIRCRAFT (9)

The Sperry Zero Reader. S. Kellogg and C. F. Fragola. *Aeronautical Engineering Review*, Vol. 8, No. 11, November, 1949, pp. 22–31, illus., diagrs., figs.

Sperry Zero Reader. Hugh Harvey. *Shell Aviation News*, No. 134, August, 1949, pp. 7–9, illus., diagrs.

The Sperry Zero Reader. M. R. Aries. *The Log*, Vol. 9, No. 9, September, 1949, pp. 213–219, illus., diagrs.

Zero Reader; An Electronic Brain for the Pilot. *Interavia*, Vol. 4, No. 4, April, 1949, pp. 199–203, illus., diagrs.

Panel-Type Recording Accelerometer for Aircraft. *Instruments*, Vol. 22, No. 8, August, 1949, pp. 728, 730, diagrs.

Decca Develops Flight Log, Gives Automatic Pinpoints. Vic Koby. *Canadian Aviation*, Vol. 22, No. 10, October, 1949, p. 44, illus.

Periscopic Sextant: U.S., British Versions; Fundamental Differences of New Navigational Devices Analyzed. *Aviation Week*, Vol. 51, No. 16, October 17, 1949, pp. 22, 24, 26, 27, illus.

Testing Aircraft Radio; New Marconi Equipment Tester (Type OA.216). *Airports & Air Transportation*, Vol. 4, No. 75, September, 1949, p. 209.

Summing up Findings on Stall Warnings; Pilots' Reports on Stalls Correlated with Readings from Special Instruments to Set up Design Criteria. *Aviation Week*, Vol. 51, No. 11, September 12, 1949, pp. 21, 22, figs. 2 references.

TEST & MEASURING

A New Condenser-Type Pressure Gage. Thomas A. Perls. *U.S., Navy, The David Taylor Model Basin, Report No. 625*, June, 1949. 58 pp., illus., diagrs., figs. 27 references.

The gage has a range of 0 to 30 lbs. per sq. in. The associated electronic circuit comprises a specially designed resonant-bridge carrier and dual demodulator system, a cathode-ray oscilloscope and a 16-mm. camera recorder, and a sequence-control system. It is sufficiently sensitive to resolve pressures of a few tenths of 1 lb. per sq. in., has linearity within 2 per cent up to a pressure of at least 30 lbs. per sq. in., and gives uniform response with frequencies from 0 to 10,000 cycles per sec. At 15,000 cycles per sec., its loss is 10 per cent and at 30,000 cycles per sec. 20 per cent. Sensitivity to quasi-static temperature changes corresponding to a pressure of about 2 lbs. per sq. in. is average, and its sensitivity to acceleration is negligible. The equipment is suitable for remote operation at distances up to 50 ft. and is free from spurious signals under extremely severe conditions.

A New Interferometer. E. R. Johnston and J. F. M. Scholes. *Australian Journal of Scientific Research, Series A, Physical Sciences*, Vol. 1, No. 4, 1948, pp. 464–471, diagrs., figs. 4 references. (Reprint.)

A modification of the Mach-Zehnder interferometer which, by collimating the light beams after they pass through the dividing plate, makes it possible to use a small dividing plate. Two pairs of lenses are used instead of one, but the pair in the auxiliary beam can be of small aperture, and the large lenses in the main beam may be replaced by parabolic mirrors.

The AEG Light-Flash Stroboscope and AEG Spark-Flash Apparatus FG 6/1. (*Verein Deutscher Ingenieure, Zeitschrift*, Vol. 87, Nos. 27–28, 39–40, July 10, October 2, 1943.) *U.S., Navy, The David Taylor Model Basin, Translation No. 190*, August, 1949. 3 pp.

On a New Accelerometer and Phenomena of Initial Vibrations in Vibration Meters. G. Gerloff. (*Forschung auf dem Gebiete des Ingenieurwesens*, Vol. 8, No. 3, May–June, 1937.) *U.S., Navy, The David Taylor Model Basin, Translation No. 141*, May, 1949. 18 pp., illus., diagrs. 4 references.

A Six-Component Dynamometer for the Measurement of Forces and Moments on Models of Ship Appendages. Phillip Eisenberg, Morris S. Macovsky, and Walter L. Stracke. *U.S., Navy, The David Taylor Model Basin, Report No. 692*, May, 1949. 17 pp., illus., diagrs., figs. 5 references.

The General Electric Slow-Motion Camera, an Instrument for Recording Phenomena of Highest Speeds at Rates of 80,000 Down to 16 Images/Sec. F. A. Raven. (*Allgemeine Elektricitäts-Gesellschaft Technische-Physikalische Werketätten.*) *U.S., Navy, The David Taylor Model Basin, Translation No. 149*, April, 1949. 6 pp., illus. 10 references.

Design of a Multifrequency Reed-Type Shock Gage with an Inertia-Operated Trigger. Milton Martin and Paul Golovato. *U.S., Navy, The David Taylor Model Basin, Report No. 654*, May, 1949. 14 pp., illus., diagrs. 2 references.

Information Obtained During an Interrogation of Dr. Federn (Carl Schenck G.M.B.H.) on Matters Connected with Vibration and Shock. A. V. Parker and J. M. S. Adams. *Gt. Brit., British Intelligence Objectives Sub-Committee, Final Report No. 1856, Item No. 1*, May 3, 1948. 54 pp., illus., diagrs., figs. 2 references. British Information Services, New York. $1.40.

A vibration machine, tested by Carl Schenck, G.m.b.H., consists essentially of a table whose movable top surface is forced to execute a linear, substantially sinusoidal vibrating motion by means of a simple lever coupling operated by a motor-driven eccentric crank mechanism. Its simple construction makes it suitable for use by unskilled personnel, and makes it superior to the out-of-balance rotating-weight type of vibration table. Although it was originally designed for maximum frequency of 70 cycles per sec., it was free of all resonances at frequencies from 0 to 100 cycles per sec. for rigid loads up to about 75 lbs. Design and construction details of the machine are given. An appendix contains a list of 34 German companies and individuals engaged in vibration studies, and briefly outlines their work.

Damage-Distance Relations for Thin Steel Diaphragms 20 Inches in Diameter Subjected to Noncontact Underwater Explosions. Charles T. Johnson. *U.S., Navy, The David Taylor Model Basin, Report No. 611*, April, 1949. 15 pp., illus., diagrs., figs. 5 references.

Some Electronic Methods of Measurement in Engineering. G. E. Bennett, G. R. Richards, and E. C. Voss. *Society of Instrument Technology, Transactions*, Vol. 1, No. 4, June, 1949, pp. 2–34, illus., diagrs.. figs. 20 references.

A brief account of the mechanical and electrical principles underlying the design of electrical pickups for the measurement of vibration, acceleration and pressure which is illustrated by reference to some recent designs of pickups. The associated circuits, for the conversion of particular pickup parameters into corresponding voltage signals are discussed.

Instruction Manual for Resonant-Bridge Carrier System, Condenser-Type Pressure Gage, and Associated Equipment. Thomas A. Perls, Richard W. Armstrong, and Charles W. Hoffman. *U.S., Navy, The David Taylor Model Basin, Report No. 680*, June, 1949. 38 pp., illus., diagrs., figs. 4 references.

A Proposed System of Instrumentation Symbols. J. K. Burkitt. *Society of Instrument Technology, Transactions*, Vol. 1, No. 4, June, 1949, pp. 50–66, diagrs.

Instrument Research. *Stockholm, State Council of Technical Research, Instruments and Measurements Conference, Catalogue*, October, 1949. 59 pp.

Condensed descriptions of devices, methods, and techniques of measurement developed by Swedish research institutions.

A Frame for Testing Structural Models. Edward Wenk, Jr. *U.S., Navy, The David Taylor Model Basin, Report No. 599*, March, 1949. 22 pp., illus., diagrs., figs. 3 references.

Exploratory Tests on Small Steel Diaphragms Subjected to Noncontact Explosion Attack. Charles T. Johnson. *U.S., Navy, The David Taylor Model Basin, Report No. 610*, April, 1949. 20 pp., diagrs.

Laws & Regulations (44)

Rate-Making and the IATA Traffic Conferences. J. G. Gazdik. *Journal of Air Law and Commerce*, Vol. 16, No. 3, Summer, 1949, pp. 298–322.

Air Mail Subsidy of Commercial Aviation. M. George Goodrick. *Journal of Air Law and Commerce*, Vol. 16, No. 3, Summer, 1949, pp. 253–279, fig.

National Policy Toward Commercial Aviation; Some Basic Problems. Lucile Sheppard Keyes. *Journal of Air Law and Commerce*, Vol. 16, No. 3, Summer, 1949, pp. 280–297.

Machine Elements (14)

AUTOMATIC CONTROL

A Generalization of Nyquist's Stability Criteria. A. Vazsonyi. *Journal of Applied Physics*, Vol. 20, No. 9, September, 1949, pp. 863–867, diagrs., figs. 1 reference.

A generalization of Nyquist diagrams is developed. These new diagrams yield a lower limit to the values of "damping ratios" and so permit the evaluation of the stability of the "degree" of stability of systems characterized by ordinary linear differential equations.

Fundamentals of Automatic Control. II. W. Oppelt. *The Engineers' Digest*, Vol. 10, No. 9, September, 1949, pp. 317–321, diagrs.

Design Equations for Servomechanisms. Benjamin Parzen. *Electrical Communication*, Vol. 26, No. 3, September, 1949, pp. 249–256, figs. 1 reference.

BEARINGS

SKF. Erland Bratt. *Saab Sonics*, No. 7, July–September, 1949, pp. 21–25, illus. Description of the facilities, methods, and products of the home establishment of the Aktiebolaget Svenska Kullagerfabriken in Sweden, parent of the organizations that manufacture and distribute SKF bearings.

Journal Bearing Lubrication. I. A. E. Roach and C. B. Griffin. *Product Engineering*, Vol. 20, No. 10, October, 1949, pp. 96–99, illus., diagrs., figs. 6 references.

GEARS & CAMS

Kinematics of Intermittent Mechanisms. III—The Spherical Geneva Wheel. S. Rappaport. *Product Engineering*, Vol. 20, No. 10, October, 1949, pp. 137–139, illus., diagr., figs.

Maintenance (25)

Boeing Service Guide, No. 24, September, 1949. 12 pp., illus., diagrs.

Contents: Stratocruiser Control Cabin Window Heating. Oil Dilution Valve Installation Precautions. Alternator Condensers. Door Warning Light. Cowl Support Ring and Toggle Latch Adjustment. Engine Control Bracket Revision. Adjustment of Fixed Cowl Flaps. Inflation of Landing Gear Shock Struts. Proper Operating Sequence for Carburetor Preheat. Control Cable Rigging Loads. Generator Blower Clamp Revision. Replenishing Turbo Oil Tanks. Fuel Boost Pump Operation Precaution.

British European Airways' Maintenance Organization; The Maintenance Control System and Premium Bonus Scheme in Use at the Northolt Base. James Hay Stevens. *Aircraft Engineering*, Vol. 21, No. 247, September, 1949, pp. 268–273, illus., diagrs.

Servicing the Aircraft of the Royal Indian Air Force. W. D. Disbrey. *Indian Skyways*, Vol. 3, No. 6, June, 1949, pp. 32, 33, 35, 36, illus.

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Materials (8)

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A Comparison of Some Carbon Molybdenum Steels on the Basis of Various Creep Limits. A. E. Johnson and H. J. Tapsell. *Institution of Mechanical Engineers, Proceedings*, Vol. 159, *War Emergency Issue No. 40*, 1948, pp. 165–172, figs.

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Surface Treatment and Finishing of Light Metals. IV—Chemical Cleaning and Pretreatment Processes. S. Wernick. *Sheet Metal Industries*, Vol. 26, No. 269, September, 1949, pp. 1953–1959. 16 references.

The Behavior of Metals Under Multiaxial Stress Systems; The Relationship Between the Applied Tensile or Direct Stress and the Torsion or Shear Stress. A. E. Johnson. *Aircraft Engineering*, Vol. 21, No. 247, September, 1949, pp. 284–286.

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Recent Progress Made in Silicone Rubber Materials. C. E. Arntzen and R. D. Rowley. *Materials & Methods*, Vol. 30, No. 4, October, 1949, pp. 73–76, illus.

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PROTECTIVE COATINGS

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Meteorology (30)

Wet Bulb Temperatures Without a Wick. Kenneth H. Jehn. *Review of Scientific Instruments*, Vol. 20, No. 9, September, 1949, pp. 668–673, illus., figs. 5 references.

A thermistor of small mass, coated with an electrically insulating material, is dipped into distilled water and exposed to the air. Evaporational cooling increases the resistance of the element, which change can be measured, calibrated, and translated into temperature readings. Measurements obtained are accurate within 0.1 °C.

The Theoretical Background of the Multiple-Pressure Tube Anemometer. Paul R. Goudy and Henry F. Colvin, III. *Review of Scientific Instruments*, Vol. 20, No. 9, September, 1949, pp. 651–655, illus., diagr., figs. 2 references.

The instrument measures wind speed and direction without having moving parts exposed to the wind. From the expression for the air flow past a quadratic surface, by the use of one system of suitably spaced impact holes, it is possible to measure the rectangular components of wind velocity in one quadrant. Another arrangement of holes takes advantage of the breakdown in flow pattern past 90° to measure wind components in all quadrants with ambiguity. The velocity components thus measured are combined in an electro-mechanical system which provides indications of speed and direction. An experimental instrument measured velocities greater than 10 m.p.h. with a degree of accuracy sufficient for practical purposes.

An Evaluation of the Use of Ground Radar for Avoiding Severe Turbulence Associated with Thunderstorms. J. K. Thompson and V. W. Lipscomb. *U.S., N.A.C.A., Technical Note No. 1960*, October, 1949. 10 pp., figs. 3 references.

An analysis of data obtained from the 1947 Ohio operations of the U.S. Weather Bureau thunderstorm project indicates that the magnitude and intensity of gusts encountered in air-mass and frontal thunderstorms may be considerably reduced by avoiding storm areas indicated by ground radar of a 10-cm. wave length. The analysis also indicates that the ground radar used becomes more effective for turbulence avoidance as the flight altitude is increased up to 25,000 ft. and is least effective at 6,000 ft.

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The Rain Required for a Radar Echo. D. W. Perrie. *American Meteorological Society, Bulletin*, Vol. 30, No. 8, October, 1949, pp. 278–281, figs. 7 references.

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Third Partial Report on Artificial Production of Precipitation; Orographic Stratiform Clouds, California, 1949. Richard D. Coons, Earl L. Jones, and Ross Gunn. *American Meteorological Society, Bulletin*, Vol. 30, No. 7, September, 1949, pp. 255, 256, figs. 3 references.

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The Terminal Velocity of Fall for Water Droplets in Stagnant Air. Ross Gunn and Gilbert D. Kinzer. *Journal of Meteorology*, Vol. 6, No. 4, August, 1949, pp. 243–248, figs. 5 references.

The Growth of Cloud Drops in Uniformly Cooled Air. Wallace E. Howell. *Harvard University, Blue Hill Meteorological Observatory, Reprint No. 6*, 1949, pp. 134–149, figs. 30 references.

Military Aviation (24)

Low and Slow—Making Seaplane History. R. R. Boettcher. *U.S. Naval Institute, Proceedings*, Vol. 75, No. 9, September. 1949, pp. 1041–1045.

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How USAF Determines Its Aircraft Needs. Richard E. Stockwell. *Aviation Operations*, Vol. 12, No. 3, September, 1949, pp. 29–34, illus., diagr.

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The Marines' Front-Line Air Force. Clifton B. Cates. *Aero Digest*, Vol. 59, No. 3, September, 1949, pp. 42, 43, 100, illus.

The Air-Ground Team. Jacob L. Devers. *Aero Digest*, Vol. 59, No. 3, September, 1949, pp. 58, 59, 106–110, illus.

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Problems of Fighter Interception. *Interavia*, Vol. 4, No. 9, September, 1949, pp. 556, 557, figs.

Unstrategic Bombing and World Ruin; By Annihilating an Enemy We Destroy Ourselves. J. F. C. Fuller. *Ordnance*, Vol. 34, No. 176, September–October, 1949, pp. 93–96, illus.

Parachute Jumping and Emergency Landing in Mountainous Country. Sven Holmberg. *Saab Sonics*, No. 7, July–September, 1949, pp. 14–16, 25, illus.

Casualties of the U.S. 8th Air Force (ETO) in War II. J. A. Rafferty. *The Military Surgeon*, Vol. 105, No. 3, September, 1949, pp. 225–227. 1 reference.

The Birth of the Indian Air Force. *The Indian Airman*, Vol. 3, No. 4, April, 1949, pp. 3–5, illus.

The Royal Swedish Air Force; A Review. Sven Holmberg. *Saab Sonics*, No. 7, July–September, 1949, pp. 12, 13, illus.

Your Air Force; Its Job, Its Organization, Its Tools. W. Stuart Symington. *U.S. Air Services*, Vol. 34, No. 9, September, 1949, pp. 9, 10.

Model Airplanes

Sonic Models Predict Tricks of Latest Jet. Andrew R. Boone. *Popular Science Monthly*, Vol. 155, No. 3, September, 1949, pp. 124, 125, illus.

How Models Cut (Lockheed) F-90 Development Cost. *Aviation Week*, Vol. 51, No. 14, October 3, 1949, p. 21, illus.

Navigation (29)

Radio Flight; How to Use the Highway in the Sky. II—The Radio Range. Sandy A. F. MacDonald. *Canadian Aviation*, 22, No. 10, October, 1949, pp. 36, 38, 40, 42, 62, 64, figs.

Navigating Across the Pacific. Fred J. Wicker. *Canadian Aviation*, Vol. 22, No. 10, October, 1949, pp. 28, 58, 60, 62, illus.

Personal Flying (42)

Rent or Buy; It's Cheaper to Own a Lightplane When Your Logbook Shows Over 200 Hours a Year. Ben Robin. *Flying*, Vol. 45, No. 4, October, 1949, pp. 32, 67, 68.

British Light Aircraft for the Private Owner. Goeffrey Dorman. *Aircraft*, Vol. 27, No. 11, August, 1949, pp. 22, 23, 28, 29, 36, 38, illus.

Photography (26)

Survey and Map Photography from Stratosphere. Pierre Lorme. *The Indian Airman*, Vol. 3, No. 7, July, 1949, pp. 9, 19, illus.

Putting Canada on the Map; Work and Training of the R.C.-A.F. Photographic Units. Robert Russell. *Flight*, Vol. 56, No. 2123, September 1, 1949, pp. 252, 253, illus.

Air Survey in Relation to Civil Engineering. Rolt Hammond. *The Engineer*, Vol. 188, No. 4884, September 2, 1949, pp. 248–251, illus., diagrs. 3 references.

The Coast and Geodetic Survey. *U.S. Naval Institute, Proceedings*, Vol. 75, No. 9, September, 1949, pp. 1047–1055, illus.

Power Plants

Chart for the Investigation of Thermodynamic Cycles in Internal Combustion Engines and Turbines. J. M. Gilchrist. *Institution of Mechanical Engineers, Proceedings*, Vol. 159, *War Emergency Issue No. 43*, 1948, pp. 335–349, figs. 8 references.

A simple chart is constructed, which allows for variable specific heat and dissociation. Suitable selection of scales shows how the temperature-internal energy graph may be used to indicate enthalpy and, for engine expansions, the work done and the energy supplied. Readings from the graph give the heat drop, velocity change, and losses in turbines and turbo-compressors. The method is applied to a general cycle which embraces the Otto, Diesel, Atkinson, Humphrey and other cycles. Internal-combustion turbine cycles and the advantages of stage reheating are discussed. Energy-mixture strength tables for temperature intervals of 200 °C. are supplied for mixtures ranging between 100 per cent weak and 20 per cent rich.

Compounding the Piston Engine. F. J. Wiegand and M. R. Rowe. *SAE Journal*, Vol. 57, No. 9, September, 1949, pp. 39–42, illus., figs. (Extended summary of a paper.)

Britain's Power Units. *Flight*, Vol. 56, No. 2124, September, 1949, pp. 309–315, illus.

Variety of Compound Engine Schemes Possible. *SAE Journal*, Vol. 57, No. 10, October, 1949, pp. 54–57, diagrs. 2 references. (Extended summary of two papers: Compound Engine Systems for Aircraft, by E. J. Manganiello, L. V. Humble, and D. S. Boman; Compound Power Plants, by P. H. Schweitzer and J. K. Salisbury.)

ROCKET (4)

A Comparison Between the Ballisite Unrestricted Solid Propellant Rocket and the Micrograin Solid Propellant Rocket. George James. *Astro-Jet*, No. 21, Summer, 1948, pp. 2–12. 8 references.

A 5-in. ballisite rocket has an empty combustion-chamber weight of 66 lbs., contains 24 lbs. of propellant and develops 4,800 lbs. thrust for one second. A comparable micrograin unit, because of lower combustion pressure, has a combustion-chamber weighing only 16 lbs. empty, contains 25 lbs. of propellant and develops 650 lbs. thrust per second. To give equal thrust, a micrograin rocket would have to weigh 50 lbs. more and consequently would travel only about half as far as the ballisite unit. The ballisite rocket is more suitable for military purposes because of its high performance and overall lighter weight, despite greater temperature sensitivity and a cost ratio of $2^1/_2$ to 5 times that of the micrograin rocket. For peacetime uses such as take-off assistance for small planes, testing landing devices for larger rockets, and as reaction brakes for emergency aircraft landing, the micrograin rocket appears superior.

Note on Shielding of Atomic Rockets. L. R. Shepherd. *British Interplanetary Society, Journal*, Vol. 8, No. 4, July, 1949, pp. 149–157, figs. 1 reference.

An extension of a previous study of the atomic-powered rocket reports additional investigations of hard gamma-ray radiation and the steps necessary to provide shielding against the effects of such radiation. One design provides a complete radiation shadow in a comparatively narrow cone enveloping the inhabited compartment. A nuclear-chemical step rocket offers possibilities for eliminating the shielding. Its final step would be a chemical rocket containing the "pay load," and the propellants themselves would act as the shield for the crew compartment.

Power for Flight. *Aeronautics*, Vol. 21, No. 4, September, 1949, pp. 54–56, illus.

Descriptions and illustrations of current turbine, jet, and reciprocating engines exhibited at the tenth display of the Society of British Aircraft Constructors at Farnborough.

X4, Germany's Smallest Liquid Rocket. Heinz Gartmann. *Interavia*, Vol. 4, No. 9, September, 1949, pp. 553–555, illus., diagrs.

Britain's First. *The Aeroplane*, Vol. 77, No. 1995, September 2, 1949, pp. 278, 279, illus., diagr., fig.

The Sprite; The First de Havilland Rocket. *de Havilland Gazette*, No. 52, August, 1949, p. 31, illus.

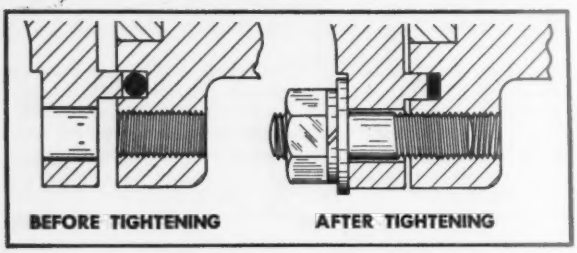
Sprite Rocket Motor; de Havilland's First Unit for Take-off Assistance, 5,000 Lb. Thrust. *Flight*, Vol. 56, No. 2124, September, 1949, p. 288, diagr., fig.

JET & TURBINE (5)

Turbine-Blade Production. *Aircraft Production*, Vol. 11, No. 132, October, 1949, pp. 323–330, illus., diagrs.

Multi-station, continuous-loading machine fixtures and cam-controlled operational cycles are features of the methods developed by the Engine Division of Bristol Aeroplane Company,

Prevent Gasoline Leakage
Even at Temperatures of −55°C. to +70°C.



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Ltd., for manufacturing turbine blades. Adaptations of standard machine tools are used in many instances instead of special-purpose machines. Grinding is used wherever possible as a basic method of material removal, because it permits continuous operation and requires less dimensional adjustment than milling or broaching.

Mechanisms of Failure of High Nickel-Alloy Turbojet Combustion Liners. John W. Weeton. *U.S., N.A.C.A., Technical Note No. 1938*, October, 1949. 45 pp., illus., diagrs., figs. 3 references.

Equilibrium Operating Performance of Axial-Flow Turbojet Engines by Means of Idealized Analysis. John C. Sanders and C. Chapin. *U.S., N.A.C.A., Technical Note No. 1956*, October, 1949. 40 pp., figs. 4 references.

The Development of Turbine Engines in France. II. *Aircraft Engineering*, Vol. 21, No. 247, September, 1949, pp. 293–295, diagrs., figs. An account of some of the experimental work carried out by the research departments of the Société Rateau at La Courneuve.

American Notebook. *Flight*, Vol. 56, No. 2127, September 29, 1949, pp. 436–439, illus.

Commentary on American engineering progress and the prospects for development by the American aircraft industry of jet or turbine-propeller powered aircraft to compare with current and future British designs.

Direct Method of Design and Stress Analysis of Rotating Disks with Temperature Gradient. S. S. Manson. *U.S., N.A.C.A., Technical Note No. 1957*, October, 1949. 31 pp., figs. 8 references.

Method of Determining Conditions of Maximum Efficiency of an Independent Turbine-Propeller Combination. Marcus F. Heidmann. *U.S., N.A.C.A., Technical Note No. 1951*, September, 1949. 20 pp., figs. 1 reference.

Turbojet Engine Performance Characteristics with Reference to Methods of Augmentation. Edward Woll. *Astro-Jet*, No. 21, Summer, 1948, pp. 13–27, diagrs., figs.

Effect of Combustor-Inlet Conditions on Performance of an Annular Turbojet Combustor. J. Howard Childs, Richard J. McCafferty, and Oakley W. Surine. *U.S., N.A.C.A., Report No. 881*, 1947. 25 pp., illus., diagrs., figs. U.S. Govt. Printing Office, Washington. $0.20.

Jet Pipe Re-Heat. E. S. Moult. *de Havilland Gazette*, No. 52, August, 1949, p. 8, figs.

Exhaust Reheat for Turbojets; A Survey of Five Years' Development Work. I. A. P. Johnstone. *Flight*, Vol. 56, No. 2124, September 8, 1949, pp. 285–287, illus., diagrs., fig.

Exhaust Reheat for Turbojets. II—Development of Later Designs to Improve Performance. A. P. Johnstone. *Flight*, Vol. 56, No. 2125, September 15, 1949, pp. 363–365, diagrs., figs.

Impact of the Jet. H. Burroughes. *Hawker Siddeley Review*, Vol. 2, No. 3, September, 1949, pp. 8–15, illus. A symposium by managers and designers of the Hawker Siddeley Group.

The de Havilland Ghost Turbojet Engine. *Aero Digest*, Vol. 59, No. 4, October, 1949, pp. 42, 43, 118, 119, illus., diagr.

Installation Features of the Ghost. *de Havilland Gazette*, No. 52, August, 1949, p. 27, diagr.

Careful Assembly Insures Impeller Balance. T. S. McCrae. *SAE Journal*, Vol. 57, No. 9, September, 1949, pp. 23, 24, illus. (Extended summary of a paper.)

Free-Piston Gasifier Conserves Turbine Alloys. L. F. Small. *SAE Journal*, Vol. 57, No. 10, October, 1949, pp. 62–64, diagrs. 6 references. (Extended summary of a paper: Free Piston Gas Generator Brightens Gas Turbine Future.)

First Details of Avro's Orenda Turbojet; New Canadian Engine Shows High Combustion Efficiency, Clean Design. Irving Stone. *Aviation Week*, Vol. 51, No. 16, October 17, 1949, p. 21, illus.

Coupled Naiad; New Information on Napier's Latest Turboprop. *Flight*, Vol. 56, No. 2125, September 15, 1949, p. 342, diagr.

Inside the Naiad. D. M. Desoutter. *Aeronautics*, Vol. 21, No. 4, September, 1949, pp. 83–87, diagrs.

A 3,415 h.p. Power Group. *The Aeroplane*, Vol. 77, No. 1999, September 30, 1949, pp. 482, 483, illus., figs.

The Napier Naiad is a coupled unit comprising two axial-flow turbines mounted side-by-side and attached to a gearbox through which a centrally located counter-rotating propeller is driven. The two-stage reduction gearing with muff-type couplings and twin free-wheeling mechanisms distributes the propeller loads

evenly between the engines and allows either engine to be stopped in flight for economical cruising.

Dart Turboprop; Details and a Colour Illustration of the Smallest Rolls-Royce Gas Turbine. *Flight*, Vol. 56, No. 2124, September 8, 1949, pp. 279–281, illus., fig.

The Dart Turbine for Civil and Military Use. *The Aeroplane*, Vol. 77, No. 1996, September 9, 1949, pp. 361–364, illus., cutaway drawing.

Bristol "Proteus" Propeller-Turbine Aero-Engine. *The Engineer*, Vol. 188, No. 4884, September 2, 1949, pp. 260–262, illus., diagr.

The Armstrong Siddeley Python. *The Aeroplane*, Vol. 77, No. 1994, August 26, 1949, pp. 256–261, illus., cutaway drawing.

Gas-Turbine Starting by Turbine; New Plessey Cartridge Starter. *Flight*, Vol. 56, No. 2127, September 29, 1949, p. 448, diagr.

Gas-Turbine Safety; Anti-Icing and Fire-Prevention Arrangements on D.H. Ghost Civil Installations. *Flight*, Vol. 56, No. 2127, September 29, 1949, p. 441, diagr.

Labyrinth Seals; Armstrong Siddeley Design and Manufacture on the Mamba. Strip Forming Methods. *Aircraft Production*, Vol. 11, No. 131, September, 1949, pp. 289, 290, illus., figs.

The Manufacture of Sheet-Metal Combustion Equipment for Jet-Propelled Aircraft. L. H. Park. *Sheet Metal Industries*, Vol. 26, No. 269, September, 1949, pp. 1935–1946, illus., diagrs., figs.

The Jet Engine Team of G. E. and Ryan. *Ryan Reporter*, Vol. 10, No. 7, August 31, 1949, pp. 8, 9, 16, 17, illus., diagr.

Power Plants at Farnborough. *The Aeroplane*, Vol. 77, No. 1997, September 16, 1949, pp. 389–391, illus.

RECIPROCATING (6)

The Development of Variable Specific Heat Charts and Graphs, and Their Application to Internal Combustion Motor Problems. W. J. Walker and C. Rogers. *Institution of Mechanical Engineers, Proceedings*, Vol. 159, *War Emergency Issue No. 42*, 1948, pp. 301–312, figs. 8 references.

A combined analytical and graphical method of investigation involves a chart and auxiliary graphs by means of which theoretical indicator diagrams may be constructed for any internal-combustion engine cycle under conditions of variable specific heat. The chart is sufficiently generalized to enable it to be used, not only for the construction and examination of indicator diagrams involving expansion down to atmospheric pressure or the initial compression volume, but to any degree of expansion. The auxiliary graphs provide a means whereby the thermal efficiency, mean effective pressure, and other data may be calculated more easily than has been possible previously. Examples are worked out for the dual combustion cycle, the Diesel cycle, and the constant-volume cycle, to illustrate the method.

The All-Important Spark Plug. G. R. Furman and Brian Corrigan. *Aero Digest*, Vol. 59, No. 4, October, 1949, pp. 20, 21, 92–94, illus., diagr., fig.

Review of the properties of various materials from which insulators and electrodes have been made, with a discussion of the principles of design. Symptoms of incorrect engine operation are revealed by inspection of spark plugs and a study of the character of deposits found on the plugs.

Civil Centaurus; Advanced Power Plant for Ambassador. *Flight*, Vol. 56, No. 2123, September 1, 1949, p. 250, illus., fig.

Production (36)

The Time to Achieve Peak Output with Special Reference to Aircraft Production. P. J. Stanley. *College of Aeronautics, Cranfield, England, Report No. 30*, July, 1949. 33 pp., figs. 7 references.

For the planning of aircraft production schedules, the setting of output rates and their use in measuring actual deliveries, an analysis was made of the rate of output growth and of the 12 to 18 months' time lapse between delivery of the first production unit to the attainment of peak output. The formula for the logistic theoretical growth curve was chosen and from that an index of the steepness of the curve representing the rate of growth was evolved as the best means of judging the relative performance attained on different projects. Statistics from 86 aircraft-production projects in the United States, Great Britain, Germany, and Japan were used.

Subcontracting Works for the Industry. *Aviation Week*, Vol. 51, No. 13, September 26, 1949, pp. 41, 42, illus.

Production Processes; Their Influence on Design. XLVI—Centrifugal Casting. Roger W. Bolz. *Machine Design*, Vol. 21, No. 9, September, 1949, pp. 107–112, illus., diagrs. 3 references.

Disperse for Survival; Industry Can Answer the Threat of Atomic Warfare. Gayle W. Arnold. *Ordnance*, Vol. 34, No. 176, September-October, 1949, pp. 103–105, illus.

Saunders-Roe Princess; Assembly of the Pressure-Hull, Alignment of Mainplane-Attachment Points, Attachment of Shell-Plating, Riveting. Wilfred E. Goff. *Aircraft Production*, Vol. 11, No. 132, October, 1949, pp. 343–351, illus., diagrs., figs.

J47 Production at Ranger. Nathaniel F. Silsbee. *Aero Digest*, Vol. 59, No. 4, October, 1949, pp. 48, 49, illus.

Progress of the Saunders-Roe Princess; Movement of Components of the First 140-Ton Flying Boat at East Cowes. *Aircraft Production*, Vol. 11, No. 131, illus., diagrs.

Contour Forming. *Aero Digest*, Vol. 59, No. 3, September, 1949, pp. 64, 102, 104, illus.

Press-Forging Thin Sections; Effect of Friction, Area, and Thickness on Pressures Required. William Schroeder and D. A. Webster. *Journal of Applied Mechanics*, Vol. 16, No. 3, September, 1949, pp. 289–294, figs. 3 references.

The application of press forging to parts with thin sections is desirable in many instances. It is generally recognized that in forging such parts, the pressure required may be very high. That this high pressure required is due to friction has been reported; however, very little specific information on the effects of friction, area, and thickness is available. The results of this analysis resemble, in some respects, those presented in an analysis of forces required in rolling by Nadai.

Tapered Skin-Plating; Weight Economy, Design and Manufacturing Considerations. *Aircraft Production*, Vol. 11, No. 131, pp. 312–314, illus., diagrs.

Cold Rolling Technique; The Application of Theory and Experiment to the Practice of Rolling. V—Resistance of Materials to Deformation. Hugh Ford. *Sheet Metal Industries*, Vol. 26, No. 269, September, 1949, pp. 1888–1893, diagrs., figs.

Skin Milling. *Aircraft Production*, Vol. 11, No. 132, October, 1949, pp. 340, 341, illus.

New Development Extends Use of Studwelding to Aluminum. J. Bland and V. A. Digiglio. *Materials & Methods*, Vol. 30, No. 3, September, 1949, pp. 78–80, illus., fig.

Gas Welds in Aluminum-Magnesium Alloy Sheet. J. Pendleton. *Institute of Welding, Transactions*, Vol. 12, No. 4, August, 1949, pp. 74–84, illus., figs. 7 references.

Factors Influencing the Weldability of High Tensile Alloy Steels, and a New Weld Cracking Test. P. L. J. Leder. *Institution of Mechanical Engineers, Proceedings*, Vol. 59, *War Emergency Issue No. 40*, 1948, pp. 173–190, illus., diagrs., figs. 20 references.

Fundamentals in Manual Arc Welding Production Costs. D. M. Kerr. *Institute of Welding, Transactions*, Vol. 12, No. 4, August, 1949, pp. 88–97, figs.

Reducing Cost of Fatigue Testing. Hanns J. Maier. *Machine Design*, Vol. 21, No. 9, September, 1949, pp. 137–139, illus., diagrs., fig.

The Martin System of Budgetary Control. *The Martin Star*, Vol. 8, No. 9, September, 1949, pp. 14, 15, illus., figs.

Design Cost Control. John Van Hamersveld. *Product Engineering*, Vol. 20, No. 9, September, 1949, pp. 81–88, diagrs., figs.

What the B-36 is Costing USAF; Comptroller Gives Breakdown for Original and Repeat Order, and Shows Financial Effect of Cancellations. Robert Hotz. *Aviation Week*, Vol. 51, No. 11, September 12, 1949, pp. 37, 38.

Electronic Control; A Review of Machine-Tool Applications for Control of Speed, Feed and Profile Machining. S. A. Ghalib. *Aircraft Production*, Vol. 11, No. 131, September, 1949, pp. 303–305, illus., diagrs.

Dimensional Control; Preventing Scrap by Observation of Dimensional Drift. *Aircraft Production*, Vol. 11, No. 132, October, 1949, p. 339, illus., figs.

A Photo-Grid Technique for Sheet Metal Elongation Measurements. *U.S., National Bureau of Standards, Technical Report No. 1375*, October, 1949. 7 pp., figs. 4 references.

The master grid, ruled with lines about 0.015 mm. wide and nominally spaced 0.25 mm. apart, is used with specimens sensitized with photoengraver's cold-top enamel. Negatives show sharp, clear lines at 50 to 100 magnifications and accuracy of spacing within 1 per cent of nominal value.

Propellers (11)

Britain's Airscrew Industry. *The Aeroplane*, Vol. 77, No. 1995, September 2, 1949, pp. 323–325, illus.

Evolution of the Propeller. Charles M. Kearns. *Western Flying*, Vol. 29, No. 9, September, 1949, pp. 14–16, illus.

Research Facilities (50)

Functions of the Research & Development Board. *Aero Digest*, Vol. 59, No. 3, September, 1949, pp. 70, 72, 102, illus.

Air Force Research and Development. Donald Putt. *Aero Digest*, Vol. 59, No. 3, September, 1949, pp. 62, 63, 104, 106, illus., diagr.

NACA Serves the Armed Forces and the Nation. John W. Crowley, Jr. *Aero Digest*, Vol. 59, No. 3, September, 1949, pp. 26–28, 110, 113, 114, illus.

Rotating Wing Aircraft (34)

Practical Helicopter Performance Charts. Edward J. Nesbitt. *Aero Digest*, Vol. 59, No. 4, October, 1949, pp. 62, 64, 66, 68, 112–114, figs.

Gross weight, air temperature, and altitude are the three principal factors affecting the performance of helicopters. Charts based on those variables and on flight tests of the Sikorsky S-51 make it possible to determine readily the service, absolute, critical, and hovering ceiling, ground effect, vertical climb, best rate of climb, flying speed, pressure altitude, density altitude, and gross weight limits for helicopters under given conditions. The curves have been found to possess sufficient accuracy for use in projecting flight operations and in checking theoretical calculations. Variations introduced by such factors as piloting technique, aircraft condition, rough air, and frequent temperature changes have been provided for in the tolerances allowed in the construction of the charts.

The Development of C.A.A. Helicopter Flight Testing. Raymond B. Maloy. *Aeronautical Engineering Review*, Vol. 8, No. 11, November, 1949, pp. 32–36, illus., figs.

Helicopters of Britain. *Aeronautics*, Vol. 21, No. 4, September, 1949, pp. 64–66, illus.

Ideas for Coaxial Helicopter Design. Paul Baumgartl. *American Helicopter*, Vol. 16, No. 10, September, 1949, pp. 6–8, 20, 21, diagrs., figs. 1 reference.

Kellett XH-10 Tests Continue. G. F. Champlin. *American Helicopter*, Vol. 16, No. 10, September, 1949, pp. 13, 24, illus.

Remarks on Blade Position Instability. Kurt H. Hohenemser. *American Helicopter*, Vol. 15, No. 9, August, 1949, p. 13, figs.

The Helicopter Serves the Military. Alexander Klemin. *Aero Digest*, Vol. 59, No. 3, September, 1949, pp. 66–69, 119–121, illus.

Our Arctic Problem. Roy E. Moore. *Ordnance*, Vol. 34, No. 176, September-October, 1949, pp. 112–114, illus.

Sciences, General (33)

MECHANICS

Energy Method for Determining Dynamic Characteristics of Mechanisms. B. E. Quinn. *Journal of Applied Mechanics*, Vol. 16, No. 3, September, 1949, pp. 283–288, figs. 4 references.

PHYSICS

Analytical Method for Determining Transmission and Absorption of Time-Dependent Radiation Through Thick Absorbers. II—Source Intensity, Time-Dependent. G. Allen. *U.S., N.A.C.A., Technical Note No. 1952*, September, 1949. 11 pp. 1 reference.

Structures (7)

Fatigue Under Combined Pulsating Stresses. H. Majors, Jr., B. D. Mills, Jr., and C. W. MacGregor. *Journal of Applied Mechanics*, Vol. 16, No. 3, September, 1949, pp. 269–276, illus., diagrs., figs. 13 references.

A special combined stress pulsator is described which was used to subject thin-walled cylindrical tubes to various ratios of combined (in phase) pulsating stresses. The material investigated was annealed SAE-1020 steel. Stress ratios in both the (+, +) and the (+, −) quadrants were applied. In addition, tension tests and uniaxial completely reversed rotating bending fatigue tests were made in the axial and tangential directions to study the anisotropy of the material. The combined stress-fatigue tests agreed best with the distortion-energy theory of strength.

Gust-Tunnel Investigation of a Flexible-Wing Model with Semichord Line Swept Back 45°. Thomas D. Reisert. *U.S., N.A.C.A., Technical Note No. 1959*, October, 1949. 13 pp., illus., figs. 3 references.

Diagrams of Flutter, Divergence and Aileron Reversal Speeds for Wings of a Certain Standard Type. A. I. van de Vooren. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. V.1397*, 1947. 11 pp., figs. 4 references. (In English.)

The flutter speed, the divergence speed, and the aileron-reversal speed are plotted against the squared ratio of the wing torsion to the uncoupled frequencies of aileron deflection resulting from control-cable stiffness. The diagrams apply to several combinations of wing density, positions of flexural and inertia axes, and aerodynamic aileron balance, and permit a reasonably complete survey of their influence. To simplify the calculations the flexural stiffness was neglected, which, especially for wings with a large density, results in a slightly inaccurate value for the flutter speed. It appeared that in almost all cases in which the aileron is completely mass-balanced, the aileron reversal speed is lower than the flutter speed. Hence, if the wing torsional stiffness is fixed by the requirement that the reversal speed exceeds the maximum attainable speed by a certain amount, the system will nearly always be free of flutter.

The Treatment of a Tab in Flutter Calculations Including a Complete Account of Aerodynamic Coefficients. A. I. van de Vooren. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. V.1386*, 1947. 30 pp., diagrs., figs. 10 references. (In English.)

The equations of motion for a wing-aileron-tab system are set forth, expressing the equilibrium of inertia, elastic, and aerodynamic forces, together with explicit formulas for computing those forces from the constructional data of the system. The elastic forces of the control mechanism, which apparently depend upon the type of tab considered, are calculated for all common designs such as the spring tab, trim tab, balance tab, etc. The aerodynamic forces are obtained by strip theory from the results of accepted studies of an oscillating airfoil in two-dimensional flow. Extensive tables give all the necessary aerodynamic functions and coefficients, as well as the numerical material required for the evaluation of Taylor series (to the spanwise coordinate) of the aerodynamic coefficients. These series are introduced to facilitate the computation of the aerodynamic integrals appearing in the approximate solutions of the equations of motion. Compressibility effects are neglected.

Accurate Calculation of Static Bending Strength. Stanley J. Weiss. *Product Engineering*, Vol. 20, No. 9, September, 1949, pp. 94–97, figs.

The theory of limit design, which considers yielding of the material, determines the static strength of flexural members more accurately than standard stress analysis procedures. Application is made to members subject to both axial load and bending moment, namely hooks, shackles, and rings, under static loads.

General Features of Plastic-Elastic Problems as Exemplified by Some Particular Solutions. Rodney Hill. *Journal of Applied Mechanics*, Vol. 16, No. 3, September, 1949, pp. 295–300. 9 references.

New complete solutions based upon the Reuss equations are obtained for various plastic-elastic problems. These include the expansion of a spherical shell and of a cylindrical hole in an infinite medium. The solutions are used to exemplify certain features common to all plastic-elastic problems, with a view to introducing valid approximations in more complex cases.

The Dynamic Response of a Simple Elastic System to Antisymmetric Forcing Functions Characteristic of Airplanes in Unsymmetric Landing Impact. Joseph B. Woodson. *Journal of Applied Mechanics*, Vol. 16, No. 3, September, 1949, pp. 310–316, figs. 2 references.

An analysis of the dynamic response of an undamped mechanical system with one degree of freedom subjected to disturbances which are described by antisymmetric forcing functions. The analysis was undertaken to throw light on the effect on the vibration of the wings caused by unsymmetric landing impact of an airplane. Two types of disturbances are considered: a full-

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sine-wave pulse, and a pulse which is the difference between two overlapping half sine waves. The results are dynamic-response-factor curves. The numerically greatest dynamic-response factors, approximately 3.24 and −3.26, resulted for a full-sine-wave pulse disturbance with a ratio of duration of impact to natural period, $T_i/T \cong 1.11$. When T_i/T is in the neighborhood of 1, the first positive peak of dynamic response is numerically less than the negative and positive peaks which follow it. For much of the range, the positive and negative dynamic-response factors are numerically approximately equal. The analysis was confined to values of T_i/T between 0.33 and 12. As T_i/T increases without limit, the positive and negative dynamic-response factors tend to 1 and −1, respectively.

Beam Deflections Solved with Matrices. J. D. Swannack. *Machine Design*, Vol. 21, No. 9, September, 1949, pp. 131–136, illus., figs. 2 references.

Readers' Forum: Comparison of the Rayleigh-Ritz and Complementary Energy Methods in Vibration Analysis. Paul A. Libby and Robert C. Sauer. *Journal of the Aeronautical Sciences*, Vol. 16, No. 11, November, 1949, pp. 700–702. 1 reference.

Compliance of Elastic Bodies in Contact. R. D. Mindlin. *Journal of Applied Mechanics*, Vol. 16, No. 3, September, 1949, pp. 259–268, figs. 8 references.

Buckling of Uniform and Stepped Columns. I. J. H. Meier. *Product Engineering*, Vol. 20, No. 10, October, 1949, pp. 119–123, figs. 2 references.

A method for analysis of buckling where greater accuracy than that offered by handbook formulas is required. It provides curves that facilitate the rapid determination of average compression stress over the cross section for various slenderness ratios, eccentricity-shape factors, and extreme fiber stresses. Other curves enable the determination of the length of a uniform cross-section column equivalent in action to a stepped column.

Stresses in and General Instability of Monocoque Cylinders with Cutouts. VII—Calculation of the Buckling Load of Cylinders with Long Symmetric Cutout Subjected to Pure Bending. N. J. Hoff, Bruno A. Boley, and Merven W. Mandel. *U.S., N.A.C.A., Technical Note No. 1963*, October, 1949. 36 pp., figs. 17 references.

The General Instability of Stiffened Cylindrical Shells Under Axial Compression. A. van der Neut. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. S.314*, 1947. 28 pp., figs. 4 references. (In English.) Calculations of the bending strength of large fuselage shells, attacking the problem of bending by considering the effect of axial compression.

Analyzing Stresses in Shells and Rings. H. D. Conway. *Machine Design*, Vol. 21, No. 10, October, 1949, pp. 122–124, figs. 5 references.

The Optimum Proportions of a Multicell Box Beam in Pure Bending. Herbert Becker. *Journal of the Aeronautical Sciences*, Vol. 16, No. 11, November, 1949, pp. 653–658, figs. 4 references.

Analysis of a Single Stiffener of an Infinite Sheet. S. U. Benscoter. *Journal of Applied Mechanics*, Vol. 16, No. 3, September, 1949, pp. 242–246, figs. 4 references.

The use of stiffened-sheet construction in aircraft design has brought about the study of many problems in mechanics in which concentrated loads are introduced into stiffeners and transferred to the sheet. In the present paper a basic problem of this type is considered. A single stiffener of finite length is assumed to be attached to a sheet of infinite extent. A concentrated force is applied to the stiffener at each end. Any given problem may be divided into symmetrical and antisymmetrical parts. The physical condition that governs the problem is that the axial strain in the stiffener must be equal to the normal strain in the sheet of all points along the stiffener. In order to formulate the solution, it is necessary to employ an influence function for the strain in the sheet. This function is known from the classical theory of elasticity. The solution is found to be governed by an integral equation which has the same form as the equation which governs spanwise air-load distribution on an airplane wing. Hence a number of mathematical methods are known for solving the equation. A numerical example is presented.

Critical Shear Stress of a Curved Rectangular Panel with a Central Stiffener. Manuel Stein and David J. Yaeger. *U.S., N.A.C.A., Technical Note No. 1972*, October, 1949. 19 pp., figs. 6 references.

A theoretical solution for the critical shear stress of a simply supported curved rectangular plate stiffened by a central stiffener offering no torsional restraint which lies in either the axial or circumferential direction. Results are obtained by means of the Galerkin method and are presented in computed curves and tables.

Bending of Rectangular Plates Subjected to a Uniformly Distributed Lateral Load and to Tensile or Compressive Forces in the Plane of the Plate. H. D. Conway. *Journal of Applied Mechanics*, Vol. 16, No. 3, September, 1949, pp. 301–309, figs. 6 references.

The Elastic Stability of Sandwich Plates. J. H. Hunter-Tod. *College of Aeronautics, Cranfield, England, Report No. 25*, March, 1949. 55 pp., figs. 3 references.

Honeycomb-Sandwich Structures. II. H. C. Engel and T. P. Pajak. *Product Engineering*, Vol. 20, No. 10, October, 1949, pp. 131–134, illus., diagrs. Analysis of physical properties, design factors, means of attachment, and repair methods.

The Elastic Stresses in Thin-Walled Tubes Caused by Internal Pressures Created by Explosions. Karl Klotter and Ruth Pich. (*Oberkommando der Kriegsmarine, Vierjahresplan, Institut für Schwingungsforschung, Amtsgruppe Mar Rüst/FEP, Research Report No. 58*, December 14, 1944.) *U.S., Navy, The David Taylor Model Basin, Translation No. 226*, July, 1949. 24 pp., figs.

Two-Spar Wing Stress Analysis. W. J. Goodey. *Aircraft Engineering*, Vol. 21, No. 247, September, 1949, pp. 287–292, 301, figs. 3 references. A method that takes into account the finite spacing of the ribs. Detailed numerical calculations and test results for a model wing test specimen are given.

Some Preliminary Information on Buckling and Ultimate Strength of Unstiffened Compression Skin Obtained Through Bending and Compression Tests on Rectangular Cross Section Aluminum Tubes. Roger A. Anderson. Stockholm, *Flygtekniska Försöksanstalten* (*The Aeronautical Research Institute of Sweden*), *Meddelande Nr. 27*, 1949. 25 pp., illus., diagrs., figs. 11 references. 2.50 Kr.

The buckling stress in bending for an idealized multiweb beam may be calculated with the same degree of accuracy as that for the critical stress for ordinary flat plates in pure compression. That result is attained through use of flat-plate stability theory which allows for the actual edge conditions of the plate elements, and through the use of an appropriate correction for the reduction in plate modulus at buckling beyond the elastic range of the material. Apparently, curvatures of the plate elements of the beam due to bending had little or no effect on the value of the skin-buckling stress. The tests established an experimental relationship between buckling stress and maximum stress which shows that a rectangular cross-section tube in pure bending is fundamentally stronger after skin buckling at stresses below the yield-point stress, than the same cross section loaded in pure compression. Probably the large strength difference indicated would not exist in similar specimens made of aluminum alloy developing high skin stresses and having a ratio of web to skin thickness of around 0.3–0.4.

The Stress Analysis of Arbitrarily Shaped Wing Structures with Shear Stress Skin and Walls. H. F. Michielsen. *Journal of the Aeronautical Sciences*, Vol. 16, No. 11, November, 1949, pp. 659–673, figs. 2 references.

Gusts and Their Alleviation. Norman S. Currey. *Interavia*, Vol. 4, No. 4, April, 1949, pp. 203–206, illus., diagrs., fig.

Gust Loads Challenge Aircraft Designers; Present-day Trends in Airplane Performance, Weight, Loading, Size, Bring Major Problem in Gust Resistance. Robert McLarren. *Aviation Week*, Vol. 51, No. 12, September 19, 1949, pp. 21, 22, 24, 25, 28, figs. 12 references.

Measurement of Deflection Curves on Aircraft and Ships. H. G. Kussmer. (*Archiv für Technisches Messen, Vol. 115-1.*) *U.S., Navy, The David Taylor Model Basin, Translation No. 211*, March, 1949. 20 pp., diagrs. 5 references.

The Static Notch-Bar Tensile Test; An Indication of Tensile Strength, Hardness, Ductility and Toughness. G. Fitzgerald-Lee. *Aircraft Engineering*, Vol. 21, No. 247, September, 1949, p. 301, fig.

Investigation of Square Sub-Sized V-Notched Charpy Specimens. Donald C. Buffum. *American Society for Testing Materials, Bulletin*, No. 160, September, 1949, pp. 45–47, figs.

A Torsion Testing Machine of 2,000,000 Inch-Pound Capacity. F. K. Chang, K. Endre Knudsen, and Bruce G. Johnston. *American Society for Testing Materials, Bulletin*, No. 160, September, 1949, pp. 49–52, illus., diagrs., fig. 1 reference.

(*Continued on page 77*)

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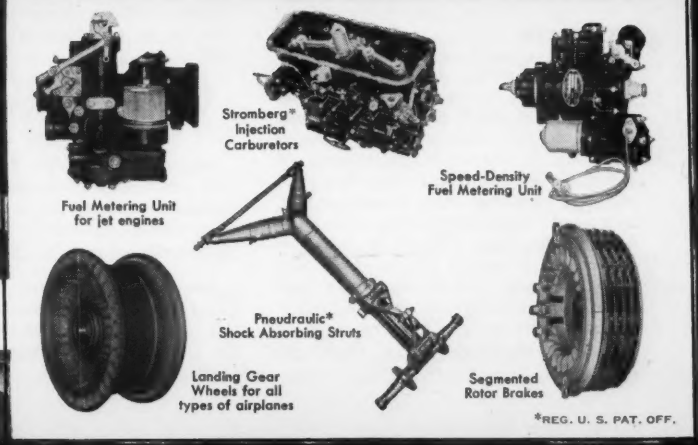
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News of Members

(*Continued from page 19*)

elected a Director of the Baltimore National Bank.

Jerry Pochy recently transferred from Patuxent River Naval Air Test Center to Naval Air Station, Cecil Field, Jacksonville, Fla., as Field Service Representative for McDonnell Aircraft Corporation. New address is Murray Hill P.O. Box 6311, Jacksonville 5, Fla.

Richard E. Reed, T.M.I.A.S., has moved from Altoona, Pa., to 1325 Watervliet Ave., Dayton, Ohio. He is Aeronautical Research, Development, and Design Engineer at Wright-Patterson Air Force Base, Dayton, Ohio.

Charles T. Roelke, M.I.A.S., resigned from United Aircraft Service Corporation and is now in the Sales Administration Department, Pratt & Whitney Aircraft Division, United Aircraft Corporation, Hartford, Conn.

W. Eugene Rohman, M.I.A.S., resigned from Thomas A. Edison, Inc., to become Sales Manager, Aeronautical Products Division, Viking Instruments, Inc., East Haddam, Conn.

Charles L. Seacord, Jr., T.M.I.A.S., is Aerodynamic Engineer for Consolidated Vultee Aircraft Corporation, Ft. Worth, Texas.

Lloyd E. Thompson, T.M.I.A.S., is an Instructor at Cal-Aero Technical Institute, Glendale 1, Calif.

PROMOTED

Fred N. Dickerman, A.F.I.A.S., has been promoted from Assistant Chief Engineer to the post of Chief Engineer by Chance Vought Aircraft, Dallas, Texas. A graduate of M.I.T. in 1930, he taught physics at Robert College, Istanbul, Turkey, for a year and then spent two years as an engineer with several small aircraft firms in the East before joining Chance Vought in 1933 as a draftsman. Placed in charge of the development group in 1938, Dickerman later served as Project Engineer on the XTBU-1 torpedo bomber and as Chief Project Engineer before becoming Chief of Design in 1943.

APPOINTED

Chance Vought, completing two top changes in its engineering department, brought in Raymond C. Blaylock, A.F.I.A.S., formerly Chief Engineer of Curtiss-Wright Airplane Division (Columbus), to fill the post of Chief of Design. Graduating with a B.S. in Aeronautical Engineering from University of Michigan in 1929, Blaylock immediately joined Curtiss-Wright as a structural engineer and in past 20 years worked up the line to post of Chief Engineer of the Airplane Division.

Juan Todaro, T.M.I.A.S., is Sales Engineer for W. M. Anderson Trading Company, Obispo 355, Havana, Cuba.

Howard J. Triani, M.I.A.S., is Group Leader—Airframes & Special Projects, Fairchild Pilotless Plane Division, Fairchild Engine and Airplane Corporation, Farmingdale, L.I., N.Y.

William D. Van Zelm, M.I.A.S., has resigned his position as Chief of New Design, The Glenn L. Martin Company, to form Van Zelm Associates, Consultants in aircraft design and development, Ruxton, Baltimore 4, Md.

Captain James H. Voyles, Jr., U.S.A.F., M.I.A.S., is Assistant Materiel Officer for Aircraft Maintenance, 85th Air Depot Wing, Erding Air Base, Erding, Germany. Address: Box 143, A.P.O. 207, c/o Postmaster, New York, N.Y.

W. C. Wold, M.I.A.S., is owner of William C. Wold Associates, representing Convair as procurement and sales consultant.

Raymond W. Young, M.I.A.S., resigned as Vice-President of Engineering, Wright Aeronautical Corporation.

Major Federico C. Zabala, C.A.F., T.M.I.A.S., was promoted recently from Captain to the permanent rank of Major in the Chilean Air Force. He still is in the Engineering Branch, located in Santiago.

Joseph E. Zimmerman, T.M.I.A.S., is Experimental Design Engineer for American Chain & Cable Company. Address is 73 Tennyson Ave., Highland Park 3, Mich.

Student Branches

Polytechnic Institute of Brooklyn

With Vice-Chairman Ralph Lesley presiding, 50 members heard Dr. Sebastian V. Nardo, Instructor in Aeronautical Engineering, speak on the aims and advantages of the I.A.S. at the October 25 meeting.

A special election was held to select a new Chairman to fill the vacancy left by Felix Murra, who left school. Lawrence Kaufman, Class of '50, was elected.

Brown University

Dr. Donald F. Hornig, Assistant Professor of Chemistry, Brown University, was the speaker at the October 17 meeting attended by 35 members. Roger B. Dowdell, Chairman, presided.

Dr. Hornig, whose subject was "The Nature of a Shock Front in Gases," reviewed existing shock-wave theory and outlined some of the methods for determining the nature of shock waves. He then discussed the experimental techniques and apparatus for creating a shock wave and of measuring its thickness using light reflection.

Cal-Aero Technical Institute

Gene May, Chief Engineering Pilot for Douglas Aircraft, was the principal speaker at the November 2 meeting, which was attended by 145 students. Chairman Frank Seery presided.

Subject of May's talk was "High Speed Flight Tests." In it he stressed the absolute necessity for personal integrity and the engineering ethics and standards of every member of an engineering department. Mr. May cited his personal experiences and described the complete confidence he felt and placed in the engineering departments with which he has worked throughout his years as Chief Test Pilot.

Following his discussion of the D-558 Skystreak, a color film was shown of the initial flight tests at Muroc Air Force Base. Mr. May then spoke on the construction and flight tests of the D-558-2 Skyrocket.

Event of the meeting was the presentation of the semiannual I.A.S. Student Branch Scholastic Award to Lloyd E. Thompson by Hugh G. Nicholson, Director of Training at Cal-Aero Tech. Mr. Nicholson was introduced by Honorary Chairman A. Victor who spoke on the nature of the scholastic evaluations made by the Engineering School Staff on each candidate eligible for the award.

Carnegie Institute of Technology

A film was shown at the October 19 meeting entitled "Aluminum." Chairman James D. Chikar presided with 17 members attending.

Case Institute of Technology

With Vice-Chairman Henry H. Homitz presiding at the October 25 meeting attended by 15 members, a film, "Science of Flight," was shown. Produced by Lockheed Aircraft, it portrayed the development of the Constellation from wind-

tunnel tests on models to physical tests on scale components and actual flight tests.

Catholic University of America

Sixty members and guests attended the organizational meeting held October 19, chairmanned by Woodrow Seamone, who outlined the aims and activities of the I.A.S.

Following his talk, two films were shown: "The AT-21 Fairchild Gunner" and "TF 1161—Aerodynamics: Forces Acting on an Airfoil."

University of Cincinnati

New officers of the Branch elected last May 17 are: Chairman, William H. Barnes; Vice-Chairman, Joseph V. Friedenheim; and Secretary-Treasurer, Betty Fulford.

University of Detroit

Twenty-eight members heard J. McViegh, Head of Research on Gas Turbines, Continental Motors, Inc., on the subject of "Small Gas Turbines" at the October 17 meeting. Jack R. Lees, Vice-Chairman, presided.

University of Florida

Vice-Chairman William F. Roberts presided at the October 18 meeting attended by 25 members.

Chief speaker was Captain Joseph L. Price, Jr., A.N.G., 159th Fighter Sq. (Florida National Guard), who talked on "Pilot's Phase of Jet-Propelled Flying."

A film on the McDonnell Phantom was shown.

University of Illinois—Chicago Undergraduate Division

A film was shown at the October 18 meeting, entitled "Airplane Propellers: Principles and Types." Chairman G. J. Zanotti presided, and 17 members attended.

University of Kansas

"Testing the B-36" was the subject presented by Ammon S. Andes, Associate Professor of Aeronautical Engineering, K.U., and formerly Aerodynamicist and Research Engineer, Consolidated Vultee Aircraft, Ft. Worth, at the October 26 meeting. Chairman John C. Adams presided with 45 members attending.

Massachusetts Institute of Technology

On October 18, Wilbur B. Huston, Project Engineer, N.A.C.A. Langley Aeronautical Laboratory, presented a talk on "Tail Buffeting," supplemented by colored films showing an F-51 stabilizer buffeting as the aircraft was put in a radical pull-up.

Chairman Charles E. Richbourg presided with 38 members attending.

At the November 1 meeting, two films were shown: "Story of the Stratocruiser," from Boeing Airplane Company, and "A Big Race for Little Wings," from Goodyear Tire & Rubber Company.

Mississippi State College

On October 17, Dr. Friedrich O. Ringleb, noted German aeronautical scientist gave the faculty and student body of the College's Engineering School an interesting lecture on aerodynamics, in which he stressed the relation of the profile of the airfoil to that of its velocity distribution. He also derived equations showing the relation of mathematics to this field of aerodynamics.

Dr. Ringleb received his doctorate from Jena University in 1926. He then taught mathematics at several European universities until 1942, when be became associated with the Messerschmitt Company, makers of the famous Me 109, Me 163, and other aircraft.

Dr. Ringleb's career has been purely academic. He became interested in the study of aerodynamics in 1937 and since that time has made several valuable contributions to both aerodynamics and the field of applied mathematics.

All members of the Branch attended the lecture.

North Carolina State College

Dr. Albert G. Guy, Head of the Metallurgy Department, was the speaker at the October 11 meeting attended by 34 members. Chairman Lester F. Wicker presided.

Dr. Guy's paper was on "High Temperature Alloys for Gas Turbines."

At the October 18 meeting, Philip L. Michel, Associate Professor of Aeronautical Engineering, spoke on "Transonic Testing."

North Dakota Agricultural College

On October 4, Honorary Chairman Prof. R. K. Watson talked on the purposes and functions of the I.A.S. Chairman Phillip A. Akin presided with 20 members attending.

Two films were shown: "Air Progress," and "Air Power is Peace Power."

A field trip was made on November 3 by ten members to Hector Airport of Fargo where the weather bureau and control tower were visited.

Northrop Aeronautical Institute

The N.A.I. Branch of the I.A.S. held a dinner meeting at the I.A.S. Building on Beverly Blvd., Los Angeles, on October 11.

Guests were John K. Northrop, President of Northrop Aircraft, Inc.; James L. Straight, Assistant Director, I.A.S.; faculty advisors and members of the University of Southern California Student Pranch of the I.A.S.; and faculty advisors and representatives of N.A.I.

Newly elected officers of the N.A.I. Branch were introduced as follows: Chairman, R. V. Gaertner; Vice-Chairman, W. G. Casey; Secretary, C. M. Hall; and Treasurer, W. S. Battis.

B. T. Person, presiding Chairman, introduced Mr. Straight, who, in turn, introduced Mr. Northrop, guest speaker, who talked on "The Development of the Flying Wing." Mr. Northrop also presented a film, "The Story of the Flying Wing," which supplemented his talk.

On November 1, members and faculty sponsors visited the Los Angeles Refinery of the Union Oil Company at nearby Wilmington, Calif. Actually seeing the production of gasoline and its many by-products and hearing of the problems encountered in the complex cracking processes were interesting sidelights to the "fuel and lubrication" study section in the power-plants course.

The group first visited the Operator Training and Exhibit Rooms, where new employees are familiarized with tools and units in their work. Here, also, were working models of the larger refining units which illustrated the different methods and steps taken in refining oil. Next shown were the extensive laboratories where close checks are kept on the quality of all outgoing and incoming products by hourly chemical analysis of samples from the various refinery divisions.

Second part of the tour was a motorcade trip through the maze of pipe lines and intricate refining sections. Guides traced completely the course of oil through the refining procedure. Emphasized were the important steps from crude-oil storage to the final processes occurring in the company's $48,000,000 Thermal Catalytic Cracking Unit, which produces top-quality gasoline.

University of Notre Dame

On October 20, Professor F. N. Brown, Head of the Aeronautical Department, gave a talk on "The Philosophy of an Aeronautical Engineer."

A film was shown at the regular meeting on November 3 entitled "The Big Race for Little Wings." Walter Geudtner, Chairman, presided. Thirty members were present. In addition, students viewed the apparatus of the laboratory, which was in operation, including the newly constructed smoke tunnel, the open-orifice wind tunnel, the Link Trainer, which the students were allowed to operate, and the rocket engine under construction by Mr. Drinkwater and Robert DeFrees.

On November 4, a tour of Bendix Aviation Products Corp., South Bend, Ind., was made by 23 members.

Ohio State University

On October 18, members made a field trip to the Lewis Flight Propulsion Laboratory in Cleveland, where they were received by Mr. Victor Gordon, Placement Director.

First point of inspection was the high-temperature material-testing laboratory where the need of this type of investigation, especially for gas-turbine work, was stressed. Testing procedures and equipment were described.

Next, the stress section was inspected, where two vibration demonstrations were made. The section was working on hollow-blade design, and an oversize model was mounted on a vibrator. When the cutaway cross section was exposed to stroboscopic light, members could see the principal modes of bending and stressing. Sand patterns on a flat disk were also used to show frequency patterns.

Next, a cutaway section of an Allison J-33 jet engine was shown to the group, and a tour of the refrigeration and air-supply facilities of the laboratories was made. The control room, where all pressure lines are indicated and where each station using different pressures for its

investigations is indicated by different lights, were shown.

Lunch was served in the cafeteria of the main building.

In the afternoon, the tour covered the two wind tunnels: the simulated-altitude tunnel, and the 8- by 6-ft. supersonic facility. Last stop of the tour was at the flight research section, where a former student of Ohio State explained the various projects.

University of Oklahoma

A technical meeting on October 14 featured Fred E. Weick, Director of Personal Aircraft Research Center, Texas A. & M., in which he spoke on "Short Takeoff Characteristics by Means of High Lift Wings."

Oregon State College

"Propulsive Systems" was the subject of a talk by Stan Lowy, Instructor, Aeronautical Engineering, Oregon State, at the October 5 meeting. Chairman Elliott R. Buxton presided with 22 members attending.

On November 10, Leo J. "Ace" Demers, Owner and Operator of Ace Flying Service, Salem, Ore., gave a talk on "Crop Dusting."

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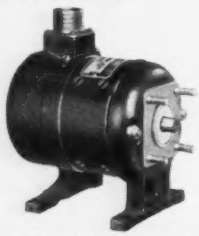

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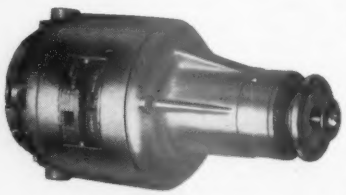

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Parks College of Aeronautical Technology

New officers elected at the September 15 meeting were: Chairman, Wallace Carr; Vice-Chairman, Joseph Eisley; Treasurer, John Wardein; Recording Secretary, Donald Grande; and Corresponding Secretary, William Menco.

The Pennsylvania State College

Two films were shown at the October 12 meeting: "Rocket Assembly and Launching," and "V-2 Rocket." Chairman John Kutney presided and 60 members attended.

On November 8, Aeronautics Instructor Charles Seaton showed films obtained from the N.A.C.A. which were entitled, "Compressibility Effects on Naval Aircraft," "Supersonic Rocket Sled," "N.A.C.A. Research," "N.A.C.A. Compressibility Film," and "N.A.C.A. Low Aspect Ratio Wings."

Stewart Technical School

Elections of officers on October 26 resulted as follows: Chairman, G. Viteritt; Vice-Chairman, Bauer; Treasurer, James V. Taxtex; Secretary, Vito W. Nuzzi.

On November 2, Chairman Viteritt discussed activities of meetings to be held in the future.

Syracuse University

Chief speaker at the October 12 meeting was Robert Wick, Instructor, Fluid Mechanics, Mechanical Engineering Department, Syracuse, who spoke on "Recent Experimental Developments in Fluid Mechanics."

In his talk, he stressed the analogy between electrical phenomena and fluid flow He also described several types of high-speed tunnels, including the shock tube, which is relatively inexpensive except for data-recording equipment.

A film, "Torpedoes in Action," was shown.

At the October 26 meeting, William W. Westcott, Senior Student, Aeronautical Engineering, gave a talk on "Aircraft Accidents That Occurred in the Army."

Texas A. & M. College

On October 18, 35 members heard Gene Clark, Assistant Chief Maintenance Engineer, Braniff Airlines, speak on "Problems of Airline Maintenance." Chairman William A. Klabunde presided.

Among the outstanding problems mentioned by Mr. Clark were: (1) serviceability and durability of equipment, (2) complexity of new design aircraft, and (3) engine reliability.

University of Texas

A business meeting was held on October 19, and the following committees were appointed: Attendance, Howard Livingston, E. C. Massingill; Publicity, Foster, Doyle Brooks; Activities, George Drake, William Higby, Edwin Hile. Dewey Younger, Chairman, presided.

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Tulsa University

On October 20, David North of American Airlines System, Inc., spoke on "Use of Heat Anti-Icing on Airliners." The talk was accompanied by slides.

In addition, two films were shown: "Aluminum Fabricating Processes," and "Blanking and Piercing."

Virginia Polytechnic Institute

A joint meeting of the Branch and Gamma Alpha Rho Society was held on October 18, when it was announced that the I.A.S.—Gamma Alpha Rho float had been awarded second place in the Homecoming Parade. The floor was turned over to President L. H. Weatherly of Gamma Alpha Rho who introduced the speaker, Professor Ralph R. Wright, Professor of Electronics, Electrical Engineering Department. Professor Wright spoke on "Development of Aircraft Sparkplug Testing." His talk included a description of the B.G. 591 spark-plug tester.

Members Elected

The following applicants for membership or applicants for change of previous grades have been admitted since the publication of the list in the last issue of the REVIEW.

Elected to Associate Fellow Grade

Conway, H. G., M.A., Technical Dir., British Messier, Ltd. (England).

Fetters, Jack C., M.E., Chief Turbine Engineer, Development Section, Allison Div., General Motors Corp.

Transferred to Associate Fellow Grade

Bolster, Calvin M., M.S. and Ae.E., Rear Adm., U.S.N.; Asst. Chief for Research & Development, Bureau of Aeronautics, Dept. of the Navy.

Gray, Harold E., Vice President, Pacific-Alaska Div., Pan American World Airways System; Member, Committee on Operating Problems, N.A.C.A.

Welmers, Everett Thomas, Ph.D., Chief of Dynamics, Bell Aircraft Corp.

Young, Raymond A., B.S. in A.E., Head, Airloads Unit, Structures Branch, Design Elements Div., Bureau of Aeronautics, Dept. of the Navy.

Elected to MEMBER Grade

Bournon, R. N., Chief Designer, F. G. Miles, Ltd., Redhill Aerodrome (England).

Chew, Bernard B., B.S.M.E., Research Engineer, Aerophysics Lab., North American Aviation, Inc.

Frick, Charles W., A.E., Head, 6- by 6-ft. Supersonic Wind Tunnel Section, Ames Aero. Lab., N.A.C.A.

Gongwer, Calvin A., M.S., Supervisor, Underwater Development, Aerojet Engineering Corp.

Gueldner, Louis O., Jr., B.S. in M.E., Design Engineer "A," Consolidated Vultee Aircraft Corp.

Gustafson, Lester W., B. of Ae.E., Aero. Dept. Head, California State Polytechnic College.

Kottas, Harry, M.Sc. in M.E., Chief, Mechanical Engineering Div., Lewis Flight Propulsion Lab., N.A.C.A.

Ludwig, Lloyd G., M.S. in M.E., Assoc. Mechanical Research Engineer, Cornell Aero. Lab., Inc.

MacDiarmid, Donald B., B.Sc., Commanding Officer, U.S. Coast Guard Air Station (San Diego).

Martin, Darrel B., B.S.Ae.E., New York Representative, Boeing Airplane Co. (Seattle).

Maximoff, Boris S., S.M., Chief Engineer, Aero. Electronics Co.

Mayes, Frank Frederick, B.A. in E., Engineering Designer, Aerophysics Lab., North American Aviation, Inc.

McNelis, John E., Lt., U.S.N.; Bureau of Aeronautics Representative, % Aviation Gas Turbine Div., Westinghouse Electric Corp.

Ogston, Alexander R., B.Sc., Technical Div. Head, Aviation Dept., Esso Export Corp.

Saben, Eric William, Company Dir., H. J. Sims & Co., Ltd. (England).

Shatz, Robert H., B. of Ae.E., Head, Special Projects Group, Cornell Aero. Lab., Inc.

Stolle, Richard, M.S. in M.E., Col., U.S.A.F.; Chief, Measurement & Analysis Branch, Air Proving Ground, Eglin Air Force Base.

Van Driest, Edward R., D.Sc. in Aero., Group Leader, Theoretical Aerodynamics, Aerophysics Lab., North American Aviation, Inc.

Wallerstein, Leon, Jr., B.S., Engineering Research Superintendent, Lord Mfg. Co.

Woodhams, Ronald James Brabant, B.Sc. in Ae.E., Project Designer, A. V. Roe & Co., Ltd. (England).

Transferred to MEMBER Grade

Ashley, Holt, M.S., Asst. Professor of Aero. Engineering, Massachusetts Institute of Technology.

Barmby, John Glennon, S.B. in Ae.E., Aero. Administrative Engineer, Bureau of Aeronautics, Dept. of the Navy.

Bireley, William P., B.S.M.E. (Aero.), Lt. Col., U.S.A.F.; Industrial Administration Student, Air Force Institute of Technology.

Head, Richard M., Ph.D. in Aero., Assoc. Professor of Aeronautics, U.S. Naval Postgraduate School.

Isakson, Gabriel, S.M. in Ae.E., Sr. Engineer, Massachusetts Institute of Technology.

Platz, Donald E., B. of Ae.E., Stress Analyst, McCulloch Motors Corp. (L. A.).

Rathert, George A., Jr., B.S.E. in Ae.E., Aero. Res. Scientist-Gr. Leader, Flight Research Section, Ames Aero. Lab., N.A.C.A.

Rogers, Milton, B.S., Aero. Engineer P-5, Sr. Research Assoc., Naval Ordnance Lab. (White Oak).

Siegel, Keeve M., B.S. in Physics, Research Assoc., University of Michigan Aero. Research Center.

Stoddard, Ray Ladd, B.S., Project Engineer, Ignition Section, Aero. & Ord. Systems Div., General Electric Co.

Walker, Merton G., Jr., B.S. in Ae.E., Engineering Planner & Estimator, McDonnell Aircraft Corp.

Winson, Jonathan, M.S. in Ae.E., Sr. Aerodynamics Engineer, In Charge of Dynamics, Pilotless Plane Div., Fairchild Engine & Airplane Corp.

Wyszpolski, Eugene Frank, M.S. in Aero., Aero. Research Engineer, Hydrodynamics Lab., California Institute of Technology.

Zachow, Arnold A., B. of Ae.E., Asst. Project Engineer, Rocket Group, Bell Aircraft Corp.

Elected to Associate Member Grade

Albert, Harry C.

Pew, George T., Asst. to Vice President, Sun Oil Co.

Transferred to Associate Member Grade

Grodson, Anthony G., B.S.Ae.E., Aero. Engineer, Aerodex, Inc.

Elected to Technical Member Grade

Cook, Kenneth S., M.S., Asst. Professor of Physics, Air Force Institute of Technology, Wright-Patterson Air Force Base.

Cox, Thomas I., Engineering Draftsman "A," North American Aviation, Inc.

Deiber, Frederick H., Design Engineer, University of California (Sandia Base Branch).

Farner, Donald R., B.S. in Ae.E., Draftsman "A," Electronics Design Group, Consolidated Vultee Aircraft Corp. (Ft. Worth).

Gunkel, Robert J., M.S.E., Aerodynamicist, Douglas Aircraft Co., Inc. (Santa Monica).

Stuart, Jay Wm., Jr., M.S. in Aero., Aerodynamicist, Douglas Aircraft Co., Inc. (El Segundo).

Valentine, Philip J., S.M.M.E., Aerodynamicist "B," Lockheed Aircraft Corp.

Transferred to Technical Member Grade

Adams, Gaynor J., M.S. in Engineering.

Amaya, Albert, Layout Draftsman, Hughes Aircraft Co.

Anthony, Frank M., B.S.Ae.E., Stress Analyst, Helicopter Group, Bell Aircraft Corp.

Ashton, John K., Jr.

Beaird, H. Grady, Jr., B.S. in Ae.E., Engineering Trainee, Chance Vought Aircraft Div., United Aircraft Corp.

Beatty, Loren A., B. of Ae.E., Aero. Engineer, N.A.C.A., Langley Air Force Base.

Blanchard, Ulysse J., B.S., Aero. Research Scientist P-1, Hydrodynamics Div., N.A.C.A., Langley Air Force Base.

Bornemann, Eldred J.

Bowen, Donald W.

Boyles, Richard Q., Jr., B. of Ae.E., Jr. Stress Analyst, NEPA Div., Fairchild Engine & Airplane Corp.

Bradfield, Ganey W., A.A. in Ae.E., Engineering Draftsman, Consolidated Vultee Aircraft Corp. (Ft. Worth).

Braniff, Carlos, B.S., Asst. to the Superintendent of Maintenance, Aérovias Guest S.A. (Mexico).

Brant, Donald A., Draftsman, Hughes Aircraft Co.

Brown, William H., B.S. in Ae.E., Jr. Engineer, Tooling Research Group, Boeing Airplane Co. (Seattle).

Casaburi, Robert R., Captain, U.S.A.F., Mather Air Force Base.

Chakmakian, Carl, B.S.Ae.E., Jr. Engineer "B," Body Group, Boeing Airplane Co. (Seattle).

Childers, Jim B., B.S. in C.E.

Cohrone, Richard F.

Cole, Ray M., Captain & Pilot, U.S.A.F.

Conrad, Harold L., B.S.Ae.E., Research Analyst "B," Power Plant Development Group, North American Aviation, Inc.

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Fernandez, Charles A., B. of Ae.E.

Ferris, R. Boyd, B.A.Sc., Design Draftsman, A. V. Roe Canada, Ltd. (Malton).

Forbriger, William S., B.S. in Ae.E.

Frezza, Arthur, A.A. in Ae.E., Tool Designer, Canadair, Ltd.

Gaidelis, John A., Balancing & Spin Test Operator, Ranger Aircraft Engines Div., Fairchild Engine & Airplane Corp.

Galvez B., Roberto, B.S. in Ae.E., Captain & Aero. Engineer, Honduras Air Force.

Gentry, E. B., Lt. Col., U.S.A.F.; Chief, Aircraft Inspection Section, Hq., Air Materiel Command, Wright-Patterson Air Force Base.

Haas, Frederick A., B. Ae.E., Illustrator & Technical Writer, Mantek Services.

Haine, James P., B.E., Aero. Engineer, Ames Aero. Lab., N.A.C.A.

Hanson, James R., B.Ae.E., Pilot, Gopher Aviation, Inc.

Harder, Keith C., Jr., M.S., Aero. Research Scientist, Physical Research Div., N.A.C.A., Langley Air Force Base.

Harris, Richard L., B.A.E.

Heilig, Louis F., M.S.Ae.E., Research Engineer, United Aircraft Corp.

Henriot, John E., B.S. in Ae.E., Jr. Engineer "B," Boeing Airplane Co. (Seattle).

Hinds, Walter E., M.S. (Aerodynamics), Aerodynamicist, Douglas Aircraft Co., Inc. (El Segundo).

Hobbs, Norman P., M.S., Jr. Engineer, Structural Dynamics, Massachusetts Institute of Technology.

Janney, Raymond B., II, B.S., Project Engineer, All American Airways, Inc.

Jones, Thomas B., Inspector, Marman Products Co., Inc.

Kawa, Russell N., Captain & Aircraft Maintenance Officer, U.S.A.F.

Kimball, Merlin A., Jr., Draftsman "B," Aerojet Engineering Corp.

Kincheloe, Iven C., Jr., B.S.Ae.E., Lt. & Flying Officer, U.S.A.F., Perrin Air Force Base.

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Madrick, Allen H., B. of Ae.E., Graduate Student, New York University.

McBride, Elmer A., Jr., M.S. in Ae.E., Design Engineer, Aircraft Gas Turbine Div., General Electric Co.

McCaskill, O. K., Jr., B.S. in Ae.E., Engineering Draftsman "B," Consolidated Vultee Aircraft Corp. (Ft. Worth).

Meledy, Thomas A., B.S., Weight Control Engineer "A," North American Aviation, Inc.

Mendel, David A., B.S. in Ae.E.

Merlet, Charles F., B.S., Aero. Engineer P-1, N.A.C.A., Langley Air Force Base.

Michelson, S., Design Draftsman, Douglas Aircraft Co., Inc. (Long Beach).

Nekola, Joseph F., B.Ae.E.

Nolan, H. D., B.S. in M.E.

Norvell, Robert A., Captain & Pilot, U.S.A.F., March Air Force Base.

Nothwang, George J., M.S., Aero. Research Scientist P-2, Ames Aero. Lab., N.A.C.A.

Novak, John T., B.Ae.E., Aero. Engineer & Pilot, Peninsular Air Transport.

O'Clock, Robert, M.S. in Ae.E., Captain, U.S.A.F.; Research & Development Engineer, Wright-Patterson Air Force Base.

Patnode, Adelard J., Draftsman, Link Aviation, Inc.

Peabody, Prentice B., Captain, U.S.A.F.; Project Officer, Guided Missiles, Holloman Air Force Base.

Pearce, John J., Liaison Engineer, Data Reduction, Northrop Aero. Institute.

Perry, Alden P., Draftsman "B," Douglas Aircraft Co., Inc. (Santa Monica).

Piercy, Thomas G., B. of Ae.E., Aerodynamicist "B," Consolidated Vultee Aircraft Corp. (Ft. Worth).

Pinter, Philip N., Grapher, Northrop Aero. Institute.

Powell, James W., B.S., Mechanical Engineer P-1, Wright-Patterson Air Force Base, U.S.A.F.

Preble, George, B.S.M.E., Aero. Engineering Draftsman, OCAMA, Tinker Air Force Base.

Royston, Harold E., Major & Navigator, U.S.A.F., Mather Air Force Base.

Ruedrich, Paul E., Jr., B.S. in Ae.E., Engineer, Flottorp Mfg. Co.

Saavedra, Joaquin A., B.S. in Ae.E., 2nd Lt., U.S.A.F.; Performance Engineer, Air Materiel Command, Muroc Air Force Base.

Schlotman, John J., B.S., Jr. Engineer "B," Boeing Airplane Co. (Seattle).

Schurmeier, Harris M., Professional Degree in Aero., Research Engineer, Jet Propulsion Lab., California Institute of Technology.

Setlock, William A., B.S. in Ae.E., Design Engineer, Bell Aircraft Corp.

Shaw, William H., B.S. in Ae.E., Technical Writer, Chance Vought Aircraft Div., United Aircraft Corp. (Dallas).

Slagle, Clifford V., B.S. in Ae.E., Jr. Design Engineer, Boeing Airplane Co. (Seattle).

Smith, Boyd L., B.S., Engineering Estimator, McInnes Steel Co.

Smith, Ellis W., Commissioned Officer, U.S.A.F., Great Falls Air Force Base.

Smith, George H., B.S. in Ae.E.

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Stefan, Karl H., M.S. in Ae.E., Lt. Cmdr., Line Officer & Naval Aviator, U.S. Navy.

Stephens, William R., B.S. in Ae.E., Engineering Draftsman, Power Plant Group, Douglas Aircraft Co., Inc. (Santa Monica).

Swartz, Eleanor G., B.S. in Ae.E., Jr. Engineer "B," Aerodynamics, Boeing Airplane Co. (Seattle).

Ughetta, Frank J., B.S., Engineer, Dynamics Group, Supersonic Lab., Massachusetts Institute of Technology.

Vaile, Richard E., A.A., Lt., U.S.A.F.; Aero. Engineer, Eglin Air Force Base.

Valle, Jean P., A.A. in AeE., Tooling Layout Draftsman, Boeing Airplane Co. (Wichita).

Van Doren, Donaldson, B.S.Ae.E., Engineering Draftsman, North American Aviation, Inc.

Wallace, Winston L., B.S. in Ae.E., Engineering Asst., Lockheed Aircraft Corp.

Watts, George A., A.A. in Ae.E., Structural Design Engineer, Grade IV, A. V. Roe Canada, Ltd. (Malton).

Weaver, Lloyd R., Liaison Engineer, Northrop Aero. Institute.

Willenborg, John A., B.S. in Ae.E., Research, Design & Development Engineer, Engineering Div., Air Materiel Command, Wright-Patterson Air Force Base.

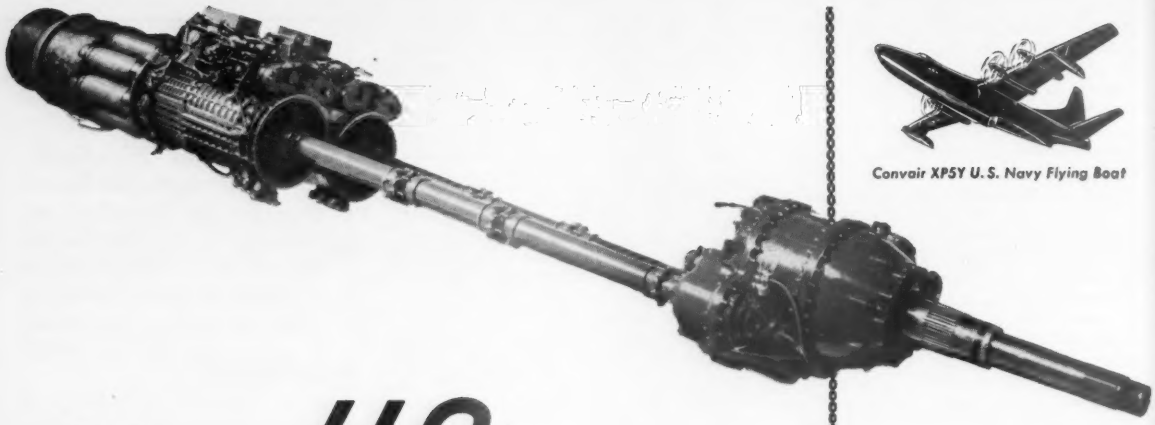
Wilson, Harold L., B.S., Captain, U.S.A.F.; Project Engineer, Bombardment Branch, Wright-Patterson Air Force Base.

Wood, Paul W., Jr., B.S., Student Officer & Pilot Training, U.S.A.F., Randolph Air Force Base.

Yenney, Warren W., Jr., B.S. in Ae.E., Aero. Engineer P-1, Vibration & Flutter Research, Naval Air Material Center, U.S. Naval Base, Station (Philadelphia).

Zeman, Gerald E., Assemblyman, Liberty Aircraft Products Corp.

Zilavy, Vladimir, Grumman Aircraft Engineering Corp.



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A new American aircraft engine — the most advanced type in the world — is now revealed by the U. S. Navy. It's the new Allison XT40 *turbo-prop* which develops more horsepower per pound of weight, with good fuel economy, than any propeller-type engine ever built by any nation. The engine currently is rated at 5500 horsepower.

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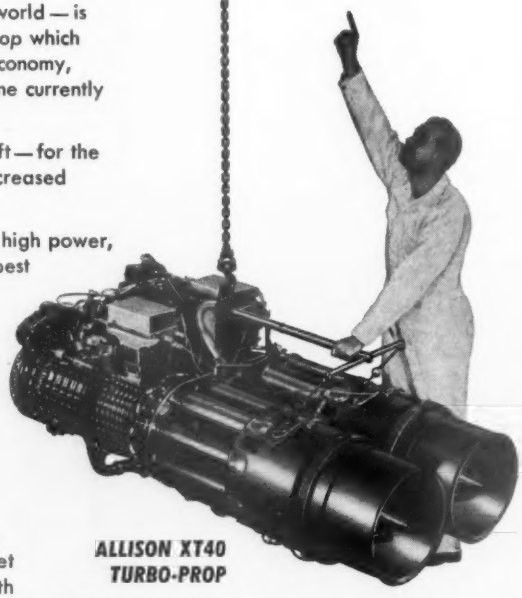
Once more Allison, a world leader in aircraft engine development and production, has made an outstanding contribution to help keep America first in the air.



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Aeronautical Reviews

Books

Heat Transfer

By Max Jakob. New York, John Wiley & Sons, Inc., 1949. Vol. I. 758 pp., figs. $12.00.

This monumental work will be a joy to the research man and the teacher. It will not, however, be the answer to the prayer of the teacher of undergraduate engineers—not because it presumes too much knowledge on the part of the reader, but because it lacks the pedestrian quality of an undergraduate text. It takes up each topic and proceeds efficiently from its beginning through to its advanced or frontier stages.

Following an introduction, the book is divided into parts A to E, each covering a major phase of the subject and each subdivided in logical fashion. Part A is entitled "Basic Equations of Heat Transfer" and is subdivided into chapters on conduction, convection, and radiation. This is a straightforward presentation of the mathematical premises of most of the chapters that follow.

Part B, which is entitled "Properties of Matter Significant to Heat Transfer," contains the basic data of the subject—namely, viscosity, thermal conductivity, and emissivity—in tabular form. The more usual practice of concentrating this material at the back of the book seems to be preferable. The author's choice was to distribute it through the text of Part B. This text covers the analytical relations that govern the variation of the magnitudes of these properties with change of state and the relationships between the magnitudes of the various properties. Methods of measurement are discussed, if at all, as problems in heat transfer in later chapters.

Part C entitled "Heat Conduction in Simple Bodies" is, quite naturally, the most mathematical in nature of all the parts. The author never shirks the task of mastering the mathematical phases of his work, although he sometimes spares the reader the most involved manipulations. He does take the trouble to instruct the reader concerning many mathematical techniques, such as Heaviside operators, Laplace transforms, conformal mapping, and relaxation methods.

As an alternative to mathematical methods he presents the method of analogy, using electrical, magnetic, or fluid analogs of heat transfer. Although this section is clear, it seems to have one defect. It does not answer the question why use electricity (for example) as an analog of heat and not heat as an analog of electricity? This matter is hinted at on p. 408, but it is nowhere adequately discussed.

Part D, entitled "Heat Convection Without Change of Phase or Constitution," is more generally a study of correlation of experimental data. Although it covers the available analytical material, the greater complexity of topic, as compared with conduction, makes it less amenable to mathematical treatment. This section includes the analytical comparisons or analogies between heat transfer and friction. It includes also a chapter on optical methods.

The next step in degree of complexity of the process, namely, "Heat Convection Including Changes of Phase," is covered in Part E. The first chapter covers the comparison of heat transfer with the mass transfer in 26 pages of rather concentrated material. The remaining two chapters are on evaporation and condensation, respectively.

At the end of the book are four appendixes. The first is a collection of graded problems that are identified with the corresponding chapters by a numbering system. The second, which is devoted to nomenclature, will be invaluable to the reader—something like it should be a part of every scientific or engineering text. The third is a table of conversion factors that includes the symbols for the quantities to be converted. The fourth is a bibliography in the form of an author index. The authors' names are arranged alphabetically and after each item the pages are listed on which reference to the item occurs. This, too, is an excellent device. It is also a most valuable list of reference in itself.

Certain deficiencies could be corrected by revision of the introduction to the book and the introductory paragraphs to certain chapters. Authors of books on heat transfer have for long presumed upon a sort of poetic license to write in terms of the caloric theory. Revocation of this license is long overdue. The least one could expect from the author of today would be an apology, in the form of a justification, for his vocabulary. If convection, which is a transfer of fluid, is to be called transfer of heat, then some explanation is in order. The present author is even more specific in implying that heat is a state function. On p. 273, for example, he says that the heat transferred away from a plate is equal to the decrease in the heat content of the plate. The only attempt to avoid this difficulty appears to occur on p. 2, where it is said that "*storage of heat energy* is the change of enthalpy (heat contents) of a medium in the path of heat transmission." This is a most unfortunate sentence, no matter how it is interpreted.

Some other introductory material needs attention. For example, on p. 19 it is stated that the property μ (the viscosity) is defined by the equation *shearing stress* $= \mu \times$ *velocity gradient*, and on p. 2 it is stated that the basic law of heat conduction is that *heat transfer rate* = *thermal conductivity* $\times A\Delta t/L$. These two statements are entirely parallel ones. If the second is the law of heat conduction, then the first is the law of flow of viscous fluids. The phraseology employed for the first, however, is much to be preferred over that for the second because it is straightforward and informative. Another example of deficiencies in introduction can be found in the treatment of radiation. Explanations and definitions of the basic concepts occur in Chapters 1 and 4, and then further "caution in definitions" is offered in Chapter 7. It would be well to have this all stated in one place. Although the author is almost always realistic (or phenomenological) in his approach, he fails to explain how one measures emissivity or reflectivity of a body. Certainly no quantitative concept is explained if the means of obtaining the magnitude of the quantity is not stated.

The credit side of the account, however, greatly exceeds the debit side. Despite his own broad experience, both analytical and experimental, the author is quick to use and acknowledge

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the contributions of others. The whole book is, in fact, the product of a prodigious labor in the literature of the subject. The particular material selected from the literature is evidence of the skill and care exercised. The high quality of the graphical work is to the credit of the publishers, but it could be attained only at the expense of much thoughtful effort on the part of the author.

Upon finishing the final page one wonders what is left for Volume II. A few things do remain. The author proposes a Part F on "Heat Radiation in Spaces of Simple Configuration," and a Part G on "Selected Fields of Application." It would seem that heat transfer to fluids in compressible flow would justify a Part H.

It is well, however, that the author did not withhold publication of Volume I until the completion of Volume II. A book like this never appears too soon.

JOSEPH H. KEENAN
Professor of Mechanical Engineering
Massachusetts Institute
of Technology

Book Notes

ELECTRONICS

The Mathematical Theory of Communication. Claude E. Shannon and Warren Weaver. Urbana, Ill., University of Illinois Press, 1949. 117 pp., diagrs. $2.50.

The theory begun by H. Nyquist (1924 and 1928) and R. V. L. Hartley (1928) is extended to include such new factors as the effect of noise in the channel, and savings possible due to the statistical structure of the original message and the nature of the final destination of the information, in a system of five parts, consisting of an information source, a transmitter, a channel, a receiver, and a destination. Discrete noiseless systems, then discrete channel with noise, and continuous information are taken up in the order of their complexity, the last two parts having been previously unpublished. These discussions are by Dr. Shannon, who is with the Bell Telephone Laboratories. Recent contributions to the Mathematical Theory of Communication, by Warren Weaver of The Rockefeller Foundation, conclude the book.

Fundamentals of Vacuum Tubes. Austin V. Eastman. 3rd edition. New York, McGraw-Hill Book Company, Inc., 1949. 644 pp., figs. $5.50.

This textbook was last revised in 1941. In the present edition extensive revisions have been made in Chapter 9, on Audio-frequency Amplifiers, and the discussion of the power-series method of analysis of vacuum-tube performance has been expanded into a new chapter. Material on modulators and detectors has been expanded into separate chapters. Discussion of ultra-high-frequency tubes and techniques has been omitted from this edition. The purpose of the author is to provide a text on the basic theory of vacuum tubes, both radio and industrial, which is neither purely descriptive nor highly mathematical. Footnote references are provided throughout, and subject and author indexes are included. The author is Head of the Electrical Engineering Department at the University of Washington.

Networks, Lines, and Fields. John D. Ryder. New York, Prentice-Hall, Inc., 1949. 462 pp., diagrs. $7.35.

This textbook aims to go further into the study of networks and transmission circuits than is usually possible in a basic alternating-current circuits course, with the requirements of the undergraduate student in mind. Networks, resonance, and wave filters are expanded with the aim of giving the student familiarity with the description of network performance by measured and defined parameters. The MKS system of units is used throughout. The author is Head of the Department of Electrical Engineering at the University of Illinois.

ENGINEERING PRACTICES

Technical Drawing. Frederick E. Giesecke, Alva Mitchell, and Henry Cecil Spencer. 3rd edition. New York, The Macmillan Company, 1949. 851 pp., illus., diagrs. $4.50.

First published in 1933, this textbook was last revised in 1942. In the present edition, a large part of the text has been rewritten, new illustrations and problems added, and several hundred old ones re-drawn. The book has been brought throughout into agreement with *American Standard Drawings and Drafting Room Practice* (1946), which is reprinted as an appendix. The chapter on Dimensioning has been almost doubled in extent, and chapters on Lettering, Multiview Drawing, Sectioning, Auxiliary Views, Fasteners, Shop Processes, Aeronautical Drafting, Pipe Fittings, and Valves, Welding, Graphs, Structural Drawing, Topographic Drawing, and Reproduction of Drawings have all been revised and expanded.

Electrical Engineers' Handbook: Electric Power. Harold Pender and William A. Del Mar, editors. 4th edition. New York, John Wiley & Sons, Inc., 1949. Various paging, illus., diagrs. $8.50.

This edition of a handbook last revised in 1936 has been entirely rewritten by 71 specialists, and reflects new developments in such theoretical subjects as circuit stability and symmetrical components, and such items of equipment as aircraft equipment, electronic rectifiers, heat pumps, servomechanisms, permanent magnets, plastic insulating materials, induction and dielectric heating apparatus, and electric resistance welding. The bibliographies have been brought up to date.

EQUIPMENT

HYDRAULIC & PNEUMATIC

Fluid Pressure Mechanisms. H. G. Conway. London and New York, Pitman Publishing Corporation, 1949. 218 pp., illus., diagrs. $5.00.

The essential principles of hydraulic, pneumatic, and compressed gas systems of high, medium, and sometimes low pressure are covered in this book, without design detail or constructional details of the equipment. The first part deals with mechanisms, including valves, pumps, receiving units, selectors, and pipe fittings. The second part covers pressure systems, including remote control, variable speed, sequence, servo, and electric control systems. The discussion is based on current practice in aircraft design and other applications.

Oil Hydraulic Power and Its Industrial Applications. Walter Ernst. New York, McGraw-Hill Book Company, Inc., 1949. 366 pp., figs. $6.00.

The first part of the book reviews the fundamentals of fluid mechanics, including the properties of hydraulic fluids, hydrostatics, hydrodynamics, and viscous and turbulent flow. The greater part is concerned with the generation of oil hydraulic power: its utilization in rotary hydraulic motors, integral hydraulic transmissions, and hydraulic cylinders; the transmission and control of hydraulic power; and applications of hydraulic power. The purpose is to present a survey of the current state of development in this field, a design guide, and a textbook. The author is Vice-President and Director of Engineering of The Commonwealth Engineering Company.

MATERIALS

Modern Methods for the Analysis of Aluminium Alloys. By a Committee of Chemists convened by The Association of Light Alloy Refiners. G. H. Osborne and W. Stross, Editors. London, Chapman & Hall, Ltd., 1949. 144 pp., illus., diagrs. 13*s*. 6*d*.

Gravimetric and volumetric, electrolytic, photometric, and polarographic methods of analysis of the usual and the less common alloying elements with aluminum are presented as the result of a survey of the best current practice in this field. Procedures for dealing rapidly with large numbers of samples, and schemes for the estimation of several elements from one weighing, are included. References to the literature are given throughout.

Metallic Creep and Creep Resistant Alloys. A. H. Sully. London, Butterworth's Scientific Publications; New York, Interscience Publishers, Inc., 1949. 278 pp., illus., diagrs. $5.50.

The first part of this book is devoted to the existing theory of strength of metals, with special reference to creep, including discussions of metallurgical factors affecting creep, and detailed discussions of experimental techniques for the study of creep phenomena. The creep properties of most ferrous and nonferrous alloys are surveyed. The final chapter deals with the nature of future research in this field. Both the industrial and the academic points of view are presented. More than 200 references are included at the ends of chapters, and subject and author indexes are provided. While creep research was applied especially to alloys used in the aircraft gas turbine field, new ranges of alloys under development may have applications wherever fuel must be converted efficiently to power, and the summary of the existing knowledge of the subject presented here is especially timely because of this potential.

The Physics of Rubber Elasticity. L. R. G. Treloar. London and New York, Oxford University Press, 1949. 255 pp., illus., diagrs $6.00.

The author's purpose is to present the essential lines of theoretical and experimental advances in the study of the elasticity of rubber. The kinetic theory of elasticity is examined, and is shown to account satisfactorily for the basic mechanical and photo-elastic properties of rubber, but deviations from the statistical theory are summarized in a separate chapter. Phenomena of crystallization, stress relaxation and flow, the dynamic properties of rubber, and the solution of engineering problems involving large elastic strains are discussed in the final chapters. A bibliography of about 125 references, and author and subject indexes, are included.

MILITARY AVIATION

The Airman's Guide, a Ready Reference of Helpful Information and Counsel for All Airmen of the United States Air Force. Harrisburg, Pa., The Military Service Publishing Company, 1949. 418 pp., illus. $2.50. (Supplement, October 6, 1949. 27 pp. Gratis.)

Intended for noncommissioned officers and aspirants to that rank, this book covers leadership qualities, the Air Force career program, rights, privileges and pay, veterans' rights, flight and survival, military justice, and general information on the Air Force. A supplement covers the provisions of the Career Compensation Act of 1949.

POWER PLANTS

Third Symposium on Combustion and Flame and Explosion Phenomena. Published under the auspices of the Standing Committee on Combustion Symposia. Bernard Lewis, Hoyt C. Hottel, and A. J. Nerad. Baltimore, The Williams & Wilkins Company, 1949. 748 pp., illus., diagrs. $13.50.

The proceedings of the first and second symposiums were published, respectively, in *In-*

dustrial and Engineering Chemistry, Vol. 20, 1928, pp. 998–1057, and *Chemical Reviews*, Vol. 21, 1937, pp. 209–460, and Vol. 22, 1938, pp. 1–310. This volume contains 100 papers on Flame Stabilization and Quenching, Flame Propagation in Explosive Gas Mixtures, Flames of Fuel Jets, Ignition of Gas Mixtures, Kinetics and Mechanism of Combustion Reactions, Flame Spectroscopy and Radiation, Burning and Detonation of Explosives, Thermodynamics of Flame Gases and Thermochemistry, Experimental Techniques, Combustion in Engines and Rockets, and Gas Burners and Furnaces.

Jet-Propelled Aircraft Powerplants. James P. Eames. San Francisco, Pacific Aero Tech, 1949. 121 pp., figs. $3.00.

The basic principles of reaction propulsion are discussed in nontechnical language. Included are chapters on pulse-jets and ram-jets, turbojets, prop-jets, and rocket-jet power plants, and on maintenance and construction materials. Three view drawings and descriptions of about 24 American and ten foreign jet-propelled aircraft, and about nine American jet engines are included in an appendix. A glossary of terms is included.

REFERENCE LITERATURE

DIRECTORIES

Standard Metal Directory. 11th edition, 1948. New York, Standard Metal Directory, 1949. 999 pp. $15.00.

This edition of a directory last revised in 1946 contains 146 new pages and features information on the capitalization, equipment, personnel, products, and materials consumed by 10,000 steel mills, foundries, smelters, rolling mills, and nonferrous metal plants in the U.S. and Canada. The plants are listed geographically and alphabetically. There are special lists of about 12,000 manufacturers of 180 metal products, ranging from aircraft to z bars; producers and distributors of pig iron, ores, ferro alloys; metal powder producers and sellers; smelters of primary and secondary nonferrous metals; storage battery manufacturers; galvanizing plants; dealers in used pipe and rails; scrap iron and scrap metal dealers; and importers and exporters.

HANDBOOKS

Fowler's Mechanical Engineer's Pocket Book, 1949. 51st annual edition. Manchester, England, Scientific Publishing Company, 1949. 459 pp., illus., diagrs. 4*s.* 6*d.*

In this edition of a handbook of long standing, new material and tables have been added, and the sections dealing with testing machines and materials have been omitted. The book is useful as a quick reference on machine elements, properties of materials, machine shop practice. steam engineering, gas engines, and conversion and other tables.

HISTORY

Interpretive History of Flight. A Survey of the History and Development of Aeronautics with Particular Reference to Contemporary Influences and Conditions. M. J. B. Davy. London, His Majesty's Stationery Office; Dallas 1, Texas, The Transportation Press, 1948. 191 pp., illus. 8*s.* 6*d.*, $2.50.

This excellent history was first published in 1937. The present edition contains a new chapter on Aircraft in the Second World War, and new material on the growth of air transport and the social and economic significance of flight. The text as a whole has not been revised. For example, new material on William Samuel Henson discovered since 1937 is not mentioned in this edition.

SCIENCES, GENERAL

ACOUSTICS

Acoustic Measurements. Leo. L. Beranek. New York, John Wiley & Sons, Inc., 1949. 914 pp., figs. $7.00.

This work brings together the scattered information on acoustic measurements, and provides in

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particular an up-to-date survey of techniques of measurement. The mathematical equations underlying each type of acoustic measurement are given, with discussion of the merits and disadvantages of alternative methods of measurement. The entire field of applications is covered, including the calibration of microphones and loudspeakers, the audiometer, the sound level meter, and the evaluation of overall radio systems. The theory of electroacoustic phemonena is covered, and references to the literature are provided in numerous footnotes, with subject and author indexes. Dr. Beranek is director of the Acoustics Laboratory, Massachusetts Institute of Technology.

MECHANICS

Applied Mechanics. Alfred P. Poorman. 5th edition. New York, McGraw-Hill Book Company, Inc., 1949. 388 pp., illus., diagrs. $4.00.

This textbook was first published in 1917, and last revised in 1940. In the new edition the text has been revised to conform with recent practice, and new material and problems have been added. Loads on structures are now given in kips instead of pounds, and a table of moments of inertia and radii of gyration of simple areas has been added. The treatment of the supplementary acceleration of bodies in plane curvilinear motion as given by the law of Coriolis is included in this edition. Problems are given immediately after each instead of at the ends of chapters. The author is a professor at Purdue University.

OPTICS

Introduction to Theoretical and Experimental Optics. Joseph Valasek. New York, John Wiley & Sons, Inc., 1949. 454 pp., illus., diagrs. $6.50.

This textbook covers geometrical optics, physical optics, and radiation and spectra, with a final section on experimental optics relating to each of these fields. A knowledge of general physics and of the calculus is expected of the reader. The book is intended as an introduction to optical engineering as well as for the intermediate and graduate student of physics. X-rays, photographic optics, and ophthalmic lenses receive more detailed treatment than is usual in textbooks on optics. A bibliography of about 100 items is included, classified under 14 subjects. The author is Professor of Physics at the University of Minnesota.

STRUCTURES

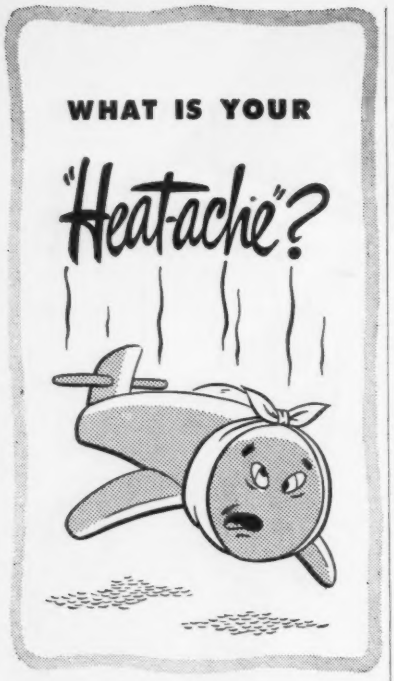
Structural Analysis by Moment Distribution. S. Butterworth. London and New York, Longmans, Green and Company, 1949. 119 pp., diagrs. $2.75.

Intended for students preparing for British university and professional examinations, and for civil and structural engineers, this book deals with the analysis of structures by moment distribution. Part I is on structures having no sidesway, and Part II is on structures under sway conditions. The structures discussed range from continuous beams consisting of two spans to frames of several members. A bibliography of 23 books and articles is included.

THERMODYNAMICS

Elements of Thermodynam-cs and Heat Transfer. Edward F. Obert. New York, McGraw-Hill Book Company, Inc., 1949. 372 pp., figs. $4.50.

This textbook is a condensation of the author's *Thermodynamics*, published in 1948. The foundation of the subject is emphasized first through definitions, then discussions of the First Law, the principle of reversibility, and the Second Law. The properties of real fluids, characteristics of real gases, and the concept of the perfect gas are next discussed, and then the applications of thermodynamics, with emphasis upon real machines, flow processes, and properties of fluids. The flow of fluids is particularly emphasized, and a final chapter is devoted to heat transfer. The author is an Associate Professor of Mechanical Engineering at Northwestern University.



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Personnel Opportunities

This section is for the use of individual members of the Institute seeking new connections and organizations offering employment to Aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute

WANTED

Research Assistant—A half-time research assistantship, paying about $112 per month and sponsored by the N.A.C.A., is available in the Department of Engineering Mechanics at the Pennsylvania State College starting February 1, 1950. The work deals with the experimental and theoretical study of behavior of metals subjected to combined stresses in the plastic range. The research work could be used for a Master's or Doctor's thesis in Engineering Mechanics. If interested, please write to Professor Joseph Marine, Department of Engineering Mechanics, The Pennsylvania State College, State College, Pa.

Professor of Aeronautical Engineering—To teach senior and graduate work in aerodynamics, aircraft design, and compressible fluids; conduct research. Administrative and wind-tunnel experience desirable. Degrees: Ph.D., D.Sc., or equivalent. Salary open. Address: Department of Aeronautical Engineering, University of Minnesota, Minneapolis 14, Minn.

Research Engineers—To perform studies on combustion problems; aid in development testing of ram-jet engines. Applicant must have experience in some phase of combustion as applied to ram-jet, turbojet, or pulse-jet engines. Ability to write acceptable reports considered important. **Aerodynamics Engineer**—With advanced degree to perform studies in aerodynamics and thermodynamics. Knowledge of supersonic aerodynamics required. Must have some knowledge of jet-power-plant field, preferably with ram-jet engines. Positions available with progressive young company on West Coast for qualified persons. Salary dependent upon qualifications. Marquardt Aircraft Company, 7801 Hayvenhurst Ave., Van Nuys, Calif.

118. Laboratory Supervisor—West Coast aircraft manufacturer needs Laboratory Supervisor with broad experience in aircraft laboratory work and special ability in the field of high-temperature steel application. Knowledge of electronics also desired. Excellent living conditions, stable employment, and opportunity for advancement available. Inquiries should include education and experience summary.

AVAILABLE

117. Aeronautical Engineer—B.Aero.E., New York University, October, 1949. Age 25; married. One and one-half years' machine-shop experience with aircraft-engine manufacturer; 2 years business office responsible position. Desires position in aircraft or allied manufacturing.

115. Airline Operations Engineering—Airport Management—Training at Denver University, Parks College, and Spartan School of Aeronautics in operations and meteorology and technical writing. Four years A.A.F. Intelligence dealing with restricted and confidential manuals in maintenance and Air Transport Command flight operations. Familiar with air-line operations problems at large Eastern airports. Also trained in A.A.F. 1st Helicopter Training Unit. Has postwar training in latest sales and airport and aircraft insurance underwriting procedures. Prewar aeronautical engineering training at V.P.I. Extension and at University of Alabama. Desires position with large fixed-base or as airport management assistant.

114. Practical Research Engineer—Civil Service Rating; Age 43. Fifteen years' aeronautical research and development experience in stability and control, specializing in high-lift and boundary-layer devices. Improved high-speed propeller designs, jet and tailless aircraft, missile designs, etc. Coordinating wind-tunnel and full-scale work. Pilot—graduate engineer. U.S.A.F.—2 years' Wright Field Technical Aide, research engineer.

113. Aeronautical Engineer—Structures—Nine years' experience with leading aircraft manufacturers since 1940. Two years as Group Structures Engineer in charge of structural design, checking, and report preparation for major components of airplane, supervising the activities of up to 10 engineers. Also preliminary design experience in structures. Has worked with both military (Army and Navy) and commercial airplanes. Two years' experience as Field Service Engineer. Graduate engineer. Age 35; married. Any location suitable.

112. Aeronautical Engineer—B.S. in Ae.E., Pennsylvania State College, June, 1949. Pilot experience during war. Desires starting position in aircraft design, development, research, or testing work. Age 26; single. Location open.

111. Engineer—Sales or Administrative. Ten years' experience in design, test, development of military aircraft. Bachelor's degrees, Purdue and Stanford Universities. Formerly officer, Marine Corps aviation. Sales Engineering experience, power plant and accessories; well acquainted with A.M.C. and BuAer, N.A.C.A. and C.A.A. Age 32; will travel anywhere; licensed pilot.

110. Aeronautical or Mechanical Engineer—B.S. Degree in Aeronautical Engineering. Graduate student for 1½ years in Aeronautics and Applied Mechanics. Approximately 3 years in the aircraft industry as a senior draftsman and aerodynamicist. Desires a position in stress analysis or aerodynamics and other related engineering work. Will accept position anywhere in the U.S. or abroad.

105. Manufacturers Military Sales Representative—Aeronautical Engineer; B.Ae.E. Fourteen years' experience both in the aviation industry and in the Air Materiel Command at Wright Field. Positions in industry included project engineer, staff engineer, and factory representative to the Air Materiel Command, covering both technical and administrative duties. Duties with A.M.C. included design, stress analysis, airplane project engineer, which afforded close and frequent contact with both A.M.C. and aviation industry engineers. Can be of value to aeronautical equipment manufacturer seeking A.F. contracts or currently a contractor to the A.F.

104. Aeronautical Engineer—B.S.A.E.; Age 33. Ten years' aircraft engineering, design, and fabrication experience, including stress analysis and testing, design group leader on surfaces, controls, and power-plant installation, assistant project engineer. Present position, Design Engineer. Familiar with Army, Navy, and C.A.A. requirements. Interested in new design and development. Available on 30 days' notice. Location open.

The number preceding the notices represents the Box Number of the Institute of the Aeronautical Sciences to which inquiries should be addressed.

103. Aeronautical Engineer—Bachelor of Aeronautical Engineering 1949; graduate of New York University, College of Engineering. Two years, 1940–1942, N.Y.U. College of Arts and Sciences. Single; age 27. Member of Officers Reserve Corps (1st Lt.—Air Force). Three years' flight experience in heavy bombardment aircraft (B-17's, B-24's) as navigator during the war. Was combat navigation instructor to B-17 crews, 1944–1945, after service with 15th A.F. in Mediterranean Theatre. Has received P-1 Rating as Aeronautical Engineer with Air Materiel Command at Wright-Patterson Air Force Base as of April, 1949. Ten years' experience in use of Leica photographic equipment in all phases of 35-mm. photographic work. Desires position with aircraft company offering opportunity for a variety of experience and willing to locate anywhere in the U.S. Complete résumé sent upon request.

102. Aeronautical & Mechanical Engineer—B.S.E. in Aero. and Mechanical from University of Michigan. Ten years' experience as design engineer, spares engineer, and head of engineering release department with one of the major aircraft manufacturers. Also 3 years' experience in the field of electronics as research mechanical engineer and mechanical development engineer. Prefers position on West Coast in research, development, design, or administrative engineering. Age 36; married.

100. Model Specialist—Precision wind-tunnel airplane-model builder; also all types of experimental machinist work done. Facilities for private contract work.

99. Aerodynamicist—B.S. in A.E.; 10 years' experience in theoretical aerodynamics, specializing in stability and control problems with government aeronautical research organization. Last 4 years engaged in theoretical supersonic aerodynamics. Desires theoretical research work in high-speed aerodynamics which may include some time in teaching theoretical aerodynamics.

98. Aeronautical Engineer—Bachelor's Degree in mechanical engineering with graduate study in mathematics and aerodynamics. Six years of experience as project engineer in theoretical and wind-tunnel research in the subsonic and transonic speed ranges with specialty in stability and control.

97. Contract Administrator—Administrative Engineer—Graduate engineer with 23 years' experience in the aviation industry, covering aircraft and engine manufacturing and active duty during the World War II in the Bureau of Aeronautics. Positions held have included responsible duties in engineering, financial, and administrative work, in most of which there was frequent contact with Government agencies, United States and foreign engineers and technicians. Most recently General Manager of a Research and Development contract coordinating opinions of authorities throughout aviation and allied sciences.

96. Industrial Training Director—Over 20 years' experience directing, supervising, and instructing all types of industrial training programs. Master's Degree in Educational Administration, Bachelor's Degree in Engineering; Licensed Professional Engineer. Experienced in sales, management, and supervisory training programs. Experience largely in aircraft field. Has college teaching experience. Will travel. Immediately available.

95. Technical Assistant to Executive Engineer—Licensed Professional Engineer with advanced degree and with extensive background in the aeronautical industry desires position with prominent aircraft manufacturing or operating organization. C.A.A. licensed commercial pilot for all conventional planes; military and civil instrument rating. Prominent in military programs. Experienced in technical writing. Free to travel.

94. Sales Engineer—Aircraft Accessories—Bach. of Aero. Eng. (N.Y.U.); is also Flight Navigator. Young man with top-notch sales ability seeks connection with manufacturer or manufacturer's representative in aircraft instruments or accessories. Three years' flying experience using all types of aircraft instruments and all navigational aids. Proficient in Pressure-Pattern Flying and Loran systems of navigation. Valuable experience as air-conditioning sales engineer has developed the "feel" of selling an engineered product. Can meet and talk to people with ease. Has proved record of sales ability. Desires position leading to sales engineering. Will undergo training and is ready to travel or relocate. Age 25; single.

93. Aeronautical Engineer—B.S.Ae.E., New York University. One and one-half years' experience with leading aircraft company in various design groups. Desires to obtain a position with company on East Coast. Age 27; single.

92. Management or Administration—Age 30; single. A. B. Degree, University of Pennsylvania. Major in political administration; courses applicable to business administration. Courses in industrial engineering, including industrial relations, business and government, and organization and organizational structure. Aeronautical engineering courses in elementary aerodynamics, performance calculation, aircraft drafting, and engineering. Almost 6 years in aircraft testing in last position. Desires permanent position on junior level in management or administration, with opportunity for advancement. Philadelphia, Pa.

91. Aerodynamicist—B.A.E., New York University. Last 3 years in the guided-missile field. Supervised reduction of flight-test data and analysis. Two years in Navy as supervisor of electronic shop and instructor in radar. Desires position with aircraft manufacturer in flight-test department, doing instrumentation or as flight analyst. Age 27; single.

90. Mechanical Engineer—With M.S. Degree, Stevens Tech., and Professional Engineer's License. Nineteen years' general engineering and business experience, including vibration and noise analysis, development of aircraft engines and accessories, and analysis of supersonic jet power plants. Languages, graduate-level teaching, and lecturing experience in aircraft engines. Desires position requiring general engineering background with experience in related activities.

89. Engineer—Background of 20 years' experience and responsibilities in military aircraft experimental design and development with major aircraft companies and 5 years, most recently, as Senior Project Engineer heading the aircraft armament and turret development section of a leading research organization. Has carried out preliminary studies and development of the structural phases of complete armament systems for the services which incorporated the latest developments in automatic sights, computers, servomechanisms, and radar components. Possesses a thoroughly sound and practical understanding of the shop and manufacturing aspects and the coordination between the engineering groups, shops, sales, and the customer. Age 46, married.

88. Development and Design Engineer—Aero. Engr.; M.S. in M.E. Fifteen years' experience in preliminary design of all types of aircraft, and development work on aircraft components and test equipment. Thorough knowledge of wind-tunnel testing and design of wind-tunnel models. Excellent training in aerodynamics, with experience in flight testing and stress analysis. Desires position that requires design and/or development work in aircraft, or similar technical position with airlines or related industry. Age 47; married. Location—East Coast preferred. Further particulars and references on request.

85. Engineer—Graduate engineer with over 19 years' experience in design, research, and manufacturing, over 12 years of which were in organizing and administering a division of engineering of a well-known aircraft company. Desires a position of responsibility with a progressive company that has good prospects for future advancement.

84. Aeronautical Engineer—Pilot—B.S. Aero.-E., 1948. One year of experience as test engineer with aircraft engines. Naval pilot for 4 years; commercial pilot with multi-engine sea and single-engine land ratings. Age 26; single; location open, foreign or domestic.

83. Aeronautical Engineer—Pilot—B. of Ae., Rensselaer Polytechnic Institute, 1949. Three months' experience in structures of pilotless aircraft. Licensed lightplane pilot. Typist. Age 22. Single. Willing to do teaching, research, or production engineering or any part of the U.S. Also willing to travel constantly. Can furnish excellent character references.

82. Research Specialist—Experience with outstanding Government and private research organizations. Experimental research in incompressible and compressible aerodynamics. Broad background in wind-tunnel problems: subsonic—5 years, asst. supervisor; supersonic—3 years. Analysis and measurements in fluid dynamics, turbulence, and boundary layer. Research engineer; planned research program. M.S. in Physics; some teaching.

79. Technical Assistant to Executive Engineer—Engineer with extensive background of experience in the aircraft industry and technical training with well-known authority in the aeronautical field desires position in checking, appraising, and formulating research and/or development programs and rendering general technical assistance. Experience includes writing pro-

posals for research and development projects and handling government contracts.

78. Aeronautical Engineer—Pilot—B.S. in Aero. E., Univ. of Ill. One and one-half years' experience as a research engineer conducting wind-tunnel research projects. Single-engine commercial and flight-instructor ratings. Currently flying F-47's in the National Guard. Desires position in aerodynamics or flight test, where flight training, experience, and education will be of benefit. Location open.

77. Engineer—Young graduate; B.S.Aero. Eng., Aircraft Design Major. Good at technical reports; desires opportunity in aeronautical field in any capacity. Interested in design and research. Good occasion for company seeking aspiring, serious individual willing to assume responsibility. Salary not important; desires trial, experience. Will relocate anywhere.

76. Associate Professor—M.S. in Math. (Physics minor); B.S. in M.E. (Structures option); B.S. in Education. Six years' teaching experience in applied mechanics (statics and dynamics), strength of materials, hydraulics, thermodynamics, aircraft stress, and Engineering Physics. Three years with major airplane company in stress analysis unit and in mechanical equipment unit. Desires teaching position in a progressive college or university. Present position satisfactory but must move because of family's health. Prefers Western States, Texas, or Florida. A detailed outline of experience will be sent upon request.

75. Aviation Technician—A.F.R.Ae.S. Three years as liaison engineer in aircraft manufacturing. Five years as engineer officer with international air line. One year as industrial engineer. Desires position with air line or aircraft manufacturer.

74. Flight Test Instrumentation Engineer—Last 4 years supervising design, manufacture, installation, and maintenance of experimental flight-test instrumentation on jet aircraft. Fifteen years' general aircraft experience on reciprocal, jet, helicopter, guided missiles. Desires connection in related work but will consider field service or sales representative. Married; age 39; free to travel. Available within 10 days.

73. Aeronautical Engineer—B.A.E., New York University. Three years' flight-test and engineering research experience, including 1 year at Wright Field. One year of sales experience, Air Force supply, and procurement experience. Graduate study in Industrial Engineering.

Aeronautical Reviews

(*Continued from page 62*)

Water-Borne Aircraft (21)

The Weight of Seaplane Floats. L. W. Rosenthal. *Royal Aeronautical Society, Journal*, Vol. 53, No. 465, September, 1949, pp. 906–910, figs. 2 references.

Studies of float form, dimensions, surface area, buoyancy, and weight show that the skin is the heaviest component, and the use of the lightest acceptable gages of plating metal for the required strength, employing the "odd" as well as the more generally used "even" gages, is advisable. Length to depth ratio should not greatly exceed the average of approximately 9:1. Frame spacing is another major factor, with fairly close spacing indicated for small floats; in larger units, the individual needs should be established by thorough investigation. Secondary and non-structural parts of the float merit careful attention since these account for about 25 per cent of the total weight. Curves based on analysis of weight and geometrical data for a large number of floats illustrate the relationship of size and buoyancy, and can be used to determine preliminary dimensions.

The Determination of Frictional Resistance. F. H. Todd. *U.S., Navy, The David Taylor Model Basin, Report No. 663*, March, 1949. 8 pp., diagr., figs.

Wind Tunnels (17)

Jet Tunnel. *Flight*, Vol. 56, No. 2127, September 29, 1949, p. 447.

Brief description of a tunnel having a working section 3 ft. 8 in. by 1 ft., powered by the jet blast from a Rolls-Royce Nene engine. A flow velocity of Mach Number 0.9 is developed in the empty tunnel, and with a model wing of 15 in. chord installed the Mach Number is 0.83, the corresponding Reynolds Number being 5 by 10^6.

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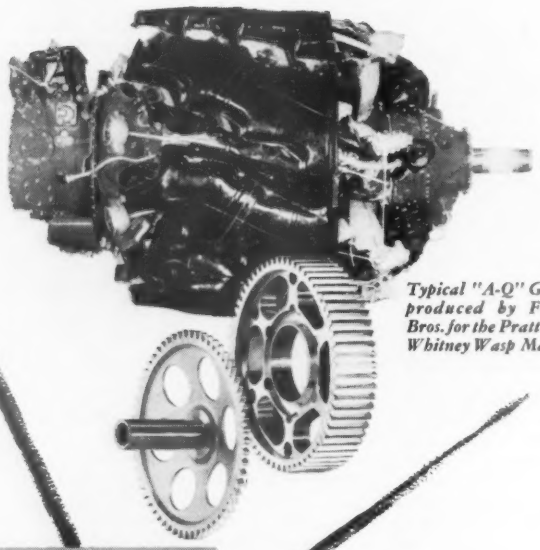

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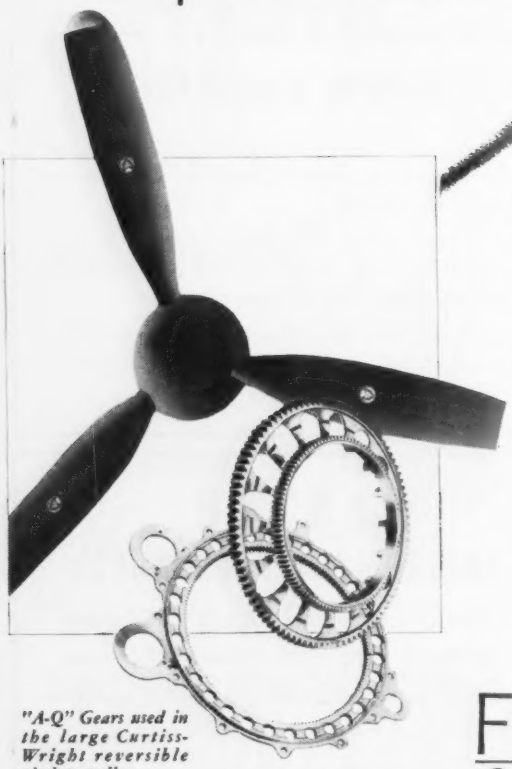

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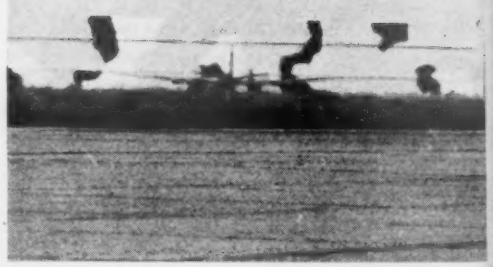

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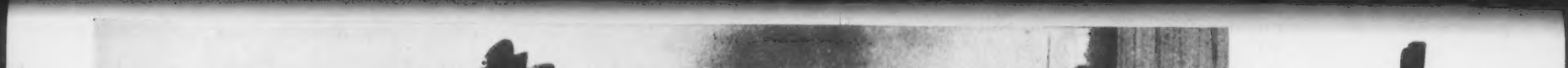
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